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A flight loads survey was performed on four CH-53A helicopters to determine whether design limits were being exceeded under actual operating conditions in the field. The survey obtained a total of 133.40 hours of valid flight data during the period May 1968 to May 1969. By means of recording oscillographs, analog records were obtained for the following parameters: (1) airspeed; (2) altitude; (3) outside air temperature; (4) normal acceleration; (5) rotary wing RPM; (6) cruise guide indication; (7) engine torque; (8) landing/take-off indication. This report presents a reduction of these data in the form of histograms, graphs and tables. Rotary wing speed was found to exceed design maximum 90% of the recorded time; this was the only parameter seriously to exceed design limits.

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Maneuvering Loads						
Rotary Wings						

DEPARTMENT OF THE NAVY
NAVAL AIR DEVELOPMENT CENTER
WARMINSTER, PA. 18974

Aero Structures Department

REPORT NO. NADC-ST-7112 15 SEPTEMBER 1971

STUDY OF CH-53A HELICOPTER FLIGHT LOAD PARAMETERS

R. Vining

FINAL REPORT

AIRTASK FOO-422-201
Work Unit 3207

A flight loads survey was performed on four CH-53A helicopters to determine whether design limits were being exceeded under actual operating conditions in the field. The survey obtained a total of 133.40 hours of valid flight data during the period May 1968 to May 1969. By means of recording oscillographs, analog records were obtained for the following parameters: (1) airspeed; (2) altitude; (3) outside air temperature; (4) normal acceleration; (5) rotary wing RPM; (6) cruise guide indication; (7) #1 engine torque, (8) landing/take-off indication. This report presents a reduction of these data in the form of histograms, graphs and tables. Rotary wing speed was found to exceed design maximum 90% of the recorded time; this was the only parameter seriously to exceed design limits.

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Technical Director

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SUMMARY

INTRODUCTION

This report presents data obtained from a flight loads survey performed on four U.S. Marine Corps CH-53A helicopters by personnel of the Naval Air Development Center, Aero Structures Department, Warminster, Pa. This work was performed under the sponsorship of the Naval Air Systems Command, AIRTASK No. F00-422-202, entitled "Helicopter Flight Loads/Dynamics." The purpose of this survey was to determine whether design limits, as outlined in references (1) and (2), were being exceeded under actual operating conditions. The survey obtained a total of 133.40 hours of valid flight data, including 69.95 hours of combat time, during the period May 1968 to May 1969.

The CH-53A helicopter is a single main rotor, two engine, assault transport designed for both land and shipboard operation. It also has the capability of landing on water in an emergency. The primary mission of this aircraft is transporting cargo and equipment with a secondary mission of transporting troops. A photo and outline drawing of the CH-53A are shown in Figure 1. Basic physical characteristics are tabulated in Table I.

The oscillographic recording systems were installed in the four aircraft, one at U.S. Marine Base, Quantico, Va. and three at U.S. Marine Corps Air Facility, Santa Ana, California. The installations were made by instrumentation personnel of the Aero Structures Department (ASD). The locations of the flight recorder and the accelerometer within the aircraft are shown in Figure 1. During the survey Marine Corps Squadron personnel attended the installations, changing recording magazines, sending the magazines containing data back to ASD along with pilot report sheets containing pertinent information for the satisfactory reduction of the recorded data and making minor repairs and adjustments as required. Parameters recorded were airspeed, altitude, outside air temperature, normal acceleration, rotary wing RPM, cruise guide indication, #1 engine torque and landing and take-off indication.

SUMMARY OF RESULTS

The CH-53A helicopters surveyed operated 10% of the recorded time above 150 kts and 2% above 160 kts. The design level maximum flight speed at basic design gross weight for this aircraft is 170 kts.

The helicopters were found to operate at rotor speeds in excess of 100% rated RPM about 90% of the total recorded time. This was the only measured parameter that was found to exceed seriously the design limitations.

Three-quarters of the recorded time, the helicopters surveyed operated at gross weights between 33,000 lbs. and 35,000 lbs. Basic design gross weight for this aircraft is 33,500 lbs.

It was found that the helicopters spent two-thirds of their recorded time with cruise guide indication below 10%. The fatigue life of rotary wing components is seriously reduced by operating above 70% cruise guide; it was found that 70% cruise guide was momentarily exceeded only six times in over 100 hrs. (An explanation of cruise guide is given in the Discussion of Data.)

The helicopters surveyed never exceeded a normal load factor of 1.8 on landing. The design normal load factor for a level landing/ maximum vertical reaction (the most severe condition) is greater than 2.

The observed normal load factors on maneuvers ranged between 0 and 2.5 for the helicopters surveyed. The design normal load factor range for this aircraft is -0.5 to 3.0.

CONCLUSIONS

Since only a limited amount of data (133 flight hours) was generated during this study, the following conclusions should be regarded as tentative rather than definitive.

1. The CH-53A helicopters operated about 90% of the time in excess of 100% normal rated rotor speed. This was the only design limit that was found to be exceeded by the helicopters upon which this study was performed.

2. Because cruise guide readings in excess of 70% were infrequently found, blade stall, and the high rotor component fatigue loadings that accompany it, should not be expected to be a problem on the CH-53 helicopter.

RECOMMENDATIONS

1. A temperature probe having a response time comparable to that of the altitude (i.e. pressure) transducer should always be used in helicopter flight load studies in order that density altitude may be calculated.

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DATA RECORDING SYSTEM

This special NADC recording system that was used to monitor CH-53A flight loads provided time histories of airspeed, altitude, normal acceleration, rotor RPM, outside air temperature, #1 engine torque, cruise guide and a take-off/landing indication. The recording system consisted of a modified Century 409 oscillograph, NADC bridge-balance unit, pressure and acceleration transducers, temperature probe, Anadex frequency converter to measure main rotor RPM, and associated components. The system weighed approximately 20 pounds. A photograph of the recorder system is shown in Figure 2.

The electrical signals for measurement of rotor speed, engine torque, and cruise guide were taken directly from the cockpit instrumentation. Airspeed and altitude were measured by pressure transducers connected directly to the pitot-static system. Outside air temperature was determined by installing a special air temperature probe. The signal for the take-off/landing event was provided by a switch on the landing gear. Vertical acceleration was measured by an accelerometer installed on the airframe at fuselage station 335, 48 inches to the right of the helicopter centerline, and 67 inches above the deck. The accelerometer installation is shown in Figure 3.

The recorder was energized when the helicopter parking brake was released. Airborne time was determined by the take-off/landing indication. Time histories were recorded on oscillograph paper 3-5/8" in width and 150 feet in length. Paper transport speed for this program was established at 5 inches per minute to obtain the best record legibility and still receive an average of five flight hours of information per magazine. A portion of one of the oscillograph records showing the traces that were recorded in flight is shown in Figure 4.

DATA PROCESSING

All flight records (oscillograms) received at NADC were processed and edited for reading. The editing procedure included entering directly on each flight record such pertinent information as gross weight, mission description, duration, etc. This information was taken from the Pilot Flight Report Form, which is shown in Figure 5. Aircraft weight changes were estimated to the nearest 500 lbs. by considering fuel consumption and on/off-loading of cargo and passengers. Thus the existing aircraft gross weight was marked at periodic intervals on the flight records.

The data reading was performed on semi-automatic data-reduction equipment. Two methods were used to read the flight data. In the first method, all parameters on the flight record were read simultaneously at intervals of one minute as indicated by the timing trace on the record.

It was thought that the one minute interval was optimum to yield maximum information at a minimum reading cost. In the second method, all parameters were read simultaneously whenever any one of three selected parameters exceeded a specified threshold value. These three parameters and their threshold values were:

A. Normal Load Factor - read whenever it is greater than 1.2 or less than -0.8.

B. Engine Torque - read whenever it is greater than 100%

C. Cruise Guide - read whenever it is greater than 30%

In addition, two other criteria must have been satisfied before a reading was made:

A. The controlling parameter (either load factor, engine torque, or cruise guide) must increase an amount equal to or greater than one-half of the amount by which it previously decreased.

B. The controlling parameter must decrease an amount equal to or greater than one-half that by which it previously increased.

Note that <u>all</u> parameters on the flight record were read whenever one of the three selected parameters satisfied the above threshold values and criteria. This was done to detect, if possible, an interrelationship between the various parameters. When the readings were made, related historical information necessary for classification was also punched upon the same computer card to facilitate later sorting, computing, and processing for the information desired.

DISCUSSION OF DATA

The data obtained from the flight survey of the CH-53A helicopter is presented in the form of histograms of the various parameters and conditions, cumulative frequency curves, and tables. In analyzing these data, it should be borne in mind that only 130 hours were recorded, a small sample. These data should be used only as a guide in design. Definitive conclusions cannot be drawn from such a limited sample.

Figure 6 is a histogram showing the percentage of flight time spent in the various airspeed ranges. It can be seen that about two-thirds of the flight time is spent in the range 80-150 knots. This is the normal operating range for the CH-53A helicopter. Less than ten percent of the total flight time was spent above 150 knots, and less than two percent above 160 knots. The design maximum level flight speed, given in References 1 and 2, is 170 knots at basic design gross weight.

Figure 7 shows percent of total flight time vs. pressure altitude. It shows that more than fifty percent of the total flight time occurred at less than 2000 ft. The reason for this is that many of the flights, in both combat and training missions, were of such short duration and distance that cruise altitude was not reached. It is more proper to use density altitude in reporting helicopter data rather than pressure altitude. However, because of the slow response of the temperature probe that was used, it was found in analyzing the recorded data that density altitude (as computed from the observed pressure and temperature) gave an erroneous picture of the helicopter operations.

Figure 8 is a histogram of the percentage of total flight time spent at various ranges of air temperature. It shows that three-quarters of the flight time occurred in air temperatures between 60° and 80° F. However, this should not be regarded as typical for helicopter operations in RVN, since this study includes training missions flown in the continental United States in a lower air temperature environment.

The term "cruise guide" used in this report refers to an electrical signal that is a direct indication of the degree of rotary wing blade stall. Blade stall limits the high speed performance of a helicopter and causes severe structural fatigue damage to the rotary wing components. The retreating blade (a blade moving away from the direction of flight) will stall because the blade tip travels at the blade tip velocity less the forward speed of the helicopter. As the velocity of the retreating blade decreases, or as airspeed increases, the blade angle of attack must be increased to obtain the necessary lift. The blade will begin to stall when the angle of attack can no longer be increased to offset the loss of rotor speed. Blade stall will first occur at the blade tip and progress toward the root as severity increases. When blade stall is developed over a large length of the blade, violent torsional vibrations of the blade will occur which can cause severe structural fatigue damage to the rotary wing components and shorten the helicopter service life. (The preceding paragraph is a condensation of a more detailed explanation of blade stall given in Part 1 of Section III of Reference 3.)

Figure 9 shows the percentage of total flight time vs. cruise guide indication (percent). It shows that two-thirds of the total flight time was spent below 10% cruise guide. Cruise guide is an indication of blade stall and rotary wing component fatigue damage. Normal operation is in the range 0 to 30 percent, as specified in Reference 3, with transient operation permitted into the 30 to 70 percent range. Figure 10, prepared from the data of Appendix A, is a histogram showing the number of peaks that occurred at various ranges of cruise guide indication. Since cruise guide is a parameter that undergoes rapid fluctuations during maneuvers, this figure presents the data on high cruise guide indications more correctly than Figure 9. Examination of these

figures indicates that about 0.5% of the total flight time was spent in cruise guide greater than 30%, that over 900 peak counts were recorded during this time, and that only 6 of these 900 peaks exceeded 70%.

Figure 11 is a histogram of the percentage of total flight time spent at various rotor speeds, expressed as a percentage of design maximum rotor speed. In Reference 2, design maximum rotor speed, with power on, is given as 185 rpm; limit rotor speed, power on, is 204 rpm, about 10% greater. This figure shows that these CH-53A helicopters were operated at rotor speeds in excess of design maximum about 90% of its total flying time, and in excess of limit about 1% of the time. The data also were grouped in 1% rotor speed increments and a second histogram was drawn, Figure 12, that was virtually identical in shape to Figure 11.

Figure 13 shows the normal acceleration upon landing vs. percentage of landings. This figure indicates than on more than two-thirds of the landings a normal acceleration of 1.2g was not exceeded, and that 1.8g was never exceeded. A normal acceleration of more than 2g is specified in Reference 4 for the most severe condition, level landing with maximum vertical reaction.

Figure 14 shows the percentage of total flight time spent in various flight regimes.

Figure 15 shows the percentage of the total number of flights vs. flight duration. It can be seen from this figure that more than two-thirds of the flights were flights of less than an hour duration, and more than 90% were flights of less than an hour-and-a-half.

Figure 16 is a histogram of the percentage of total flight time vs. gross weight. It indicates that about three-quarters of the total flight time of this helicopter takes place with the gross weight between 33,000 lbs. and 35,000 lbs. Basic design gross weight is specified as 33,500 lbs. in References 1 and 2, and design alternate gross weight is specified as 39,450 lbs. in Reference 2.

Table 3 gives a summary of the total number of takeoffs and landings recorded and the elapsed time of each record. It can be seen that some records show one more takeoff than landing; this paradox can be explained by the fact that the end of the record was reached before landing. Note that whereas the CH-53A helicopters averaged about 7 takeoffs and landings per hour of elapsed record time, the variation between records was quite large, ranging from less than 2 to more than 26 takeoffs and landings per hour. There does not seem to be a large difference in the number of takeoffs and landings per hour between the two aircraft that were operated in combat and the two that were operated only in the United States.

Figures 17 and 18 show the frequency of equalling or exceeding a given normal load factor. It can be seen that the CH-53A helicopters did not undergo high normal accelerations, 2.5g positive to 0g negative being the range experienced. Reference 2 specifies a maximum positive acceleration of 3g, and a minimum negative acceleration of -0.5g.

ACKNOWLEDGMENTS

The author wishes to acknowledge the assistance during this study of Messrs. Robert McAvoy and David Rhoads; also Mr. Thomas Blythe, who supervised the installation of the instrumentation, and Mr. William Brown who wrote the data processing computer program.

REFERENCES

1. Specification SD-522-1, "Detail Specification for Model CH-53A Helicopter"; November 1962.

2. Sikorsky Aircraft Report No. SER-65165, "Flight Loads Criteria", August 1963.

3. NAVAIR 01-230HMA-1, "Flight Manual, Navy Model CH-53A/D Helicopters." April 1969.

4. Sikorsky Aircraft Report No. SER-65166, "Ground Loads Criteria", June 1963.

TABLE 1

PHYSICAL CHARACTERISTICS OF THE CH-53A HELICOPTER

Model	CH-53A
Manufacturer	Sikorsky Aircraft (UAC)
Power	(2) T64-GE-6 engines of 2,850 SHP each
Length (max., rotary wing blade extended)	88' 2"
Width (max., rotary wing blade extended)	72' 2.7"
Height (Max., to top of rotary rudder, blade vertical)	24' 11"
Basic Weight	22,900 lbs.
Gross Weight (max.)	42,000 lbs.
Cruise Speed (8,000 lbs. of cargo, sea level, standard)	150 Knots, IAS.

Table 2

CH-53A HELICOPTERS EQUIPPED WITH RECORDING SYSTEMS

Aircraft Serial No.	Squadron	Squadron Location	Date Instrument. Installed	Date of Squadron Change	New Squadron	New Squadron Location	Period of Data Acquisition	Total Hours of Valid Flight Data
153296	HMX-1	Marine Corps. Air Station, Quantico, Va.	2/10/68	-	-	-	Feb. 1968 to June 1968	28.22
153726	HMH-462	Marine Corps. Air Station Santa Ana, Calif.	3/6/68	8/8/68	HMH-301	Marine Corps. Air Station Santa Ana, Calif.	March 1968 to May 1969	35.23
153706	"	"	3/1/68	5/1/68	HMH-463	Republic of South Vietnam	May 1968 to Dec. 1968	37.10
151701	"	"	3/5/68	5/1/68	HMH-463	"	March 1968 to April 1969	32.85

TABLE 3

CH-53 HELICOPTER

SUMMARY OF TOTAL NUMBER OF TAKEOFFS AND LANDINGS VS. TOTAL HOURS

Serial No.	Record No.	Hours	Takeoffs	Landings
151701	1	.68	1	1
"	2	1.28	17	17
"	3	2.76	10	10
"	4	2.73	12	12
"	5	4.09	15	15
"	6	2.70	13	13
"	7	3.73	10	10
"	8	4.76	9	9
"	9	3.88	16	16
"	10	3.78	18	18
"	12	2.46	6	6
		32.85	127	127
153296	2	1.46	10	10
"	4	3.35	8	8
"	5	3.33	11	11
"	6	2.78	9	9
"	7	4.11	37	37
"	8	2.31	6	6
"	9	1.66	20	20
"	11	3.93	5	5
"	12	.53	4	4
"	13	2.28	9	9
"	20	2.48	3	3
		28.22	122	122
153706	1	.63	1	1
"	2	.90	1	1
"	5	3.98	10	10
"	6	2.96	13	13
"	7	4.15	17	17
"	8	5.11	18	18
"	9	4.61	18	18
"	10	4.31	16	16
"	11	4.31	18	18
"	12	4.56	22	22
"	13	1.58	9	9
		37.10	143	143

Table 3 (Cont'd)

Serial No.	Record No.	Hours	Takeoffs	Landings
153726	2	4.43	7	6
"	3	4.30	4	3
"	4	4.41	34	34
"	6	4.84	4	3
"	7	4.43	15	15
"	8	5.10	6	5
"	9	5.28	5	4
"	10	2.03	2	2
"	11	.41	0	0
		35.23	77	72
TOTAL	41	133.40	469	464

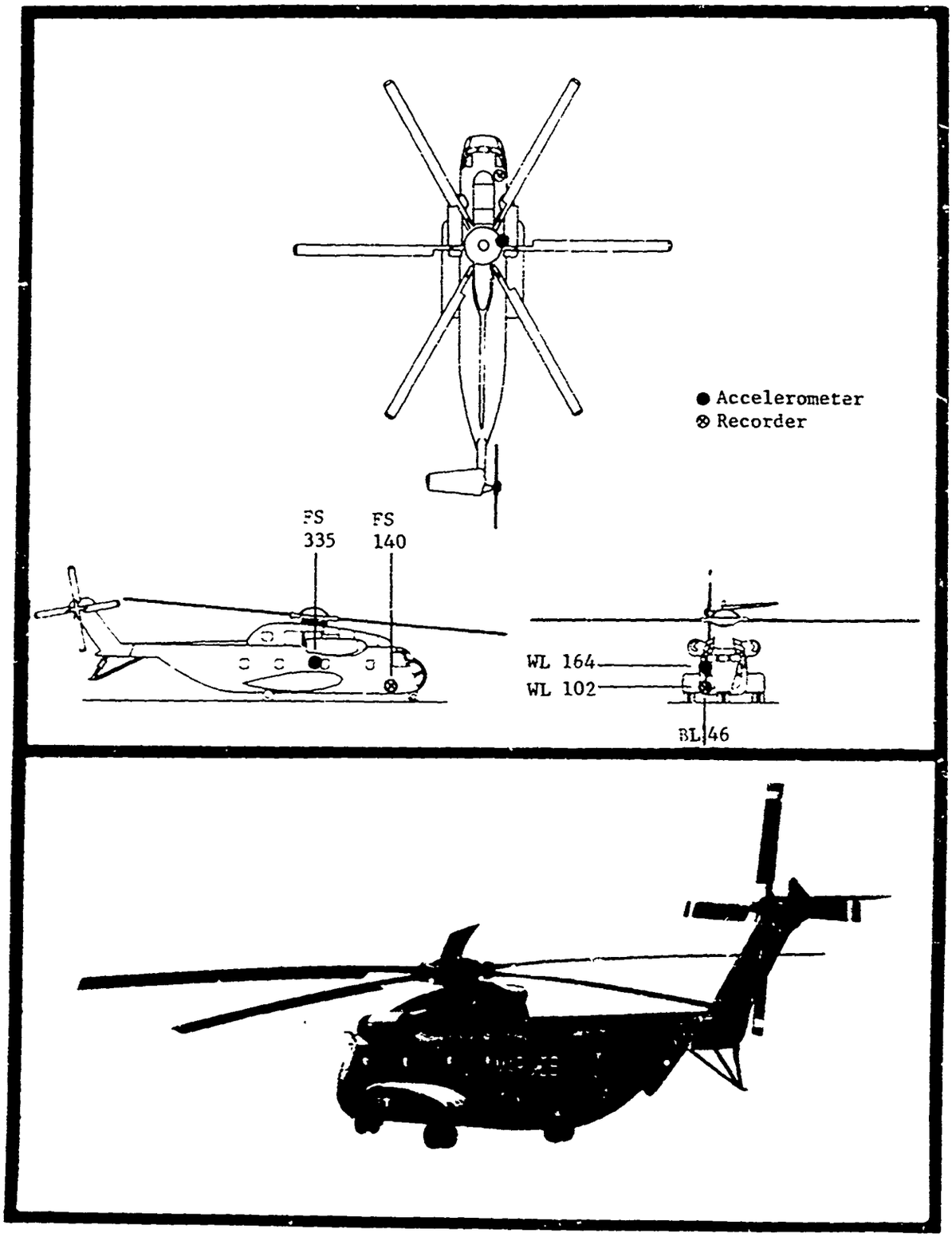

Figure 1 -- CH-53A Helicopter

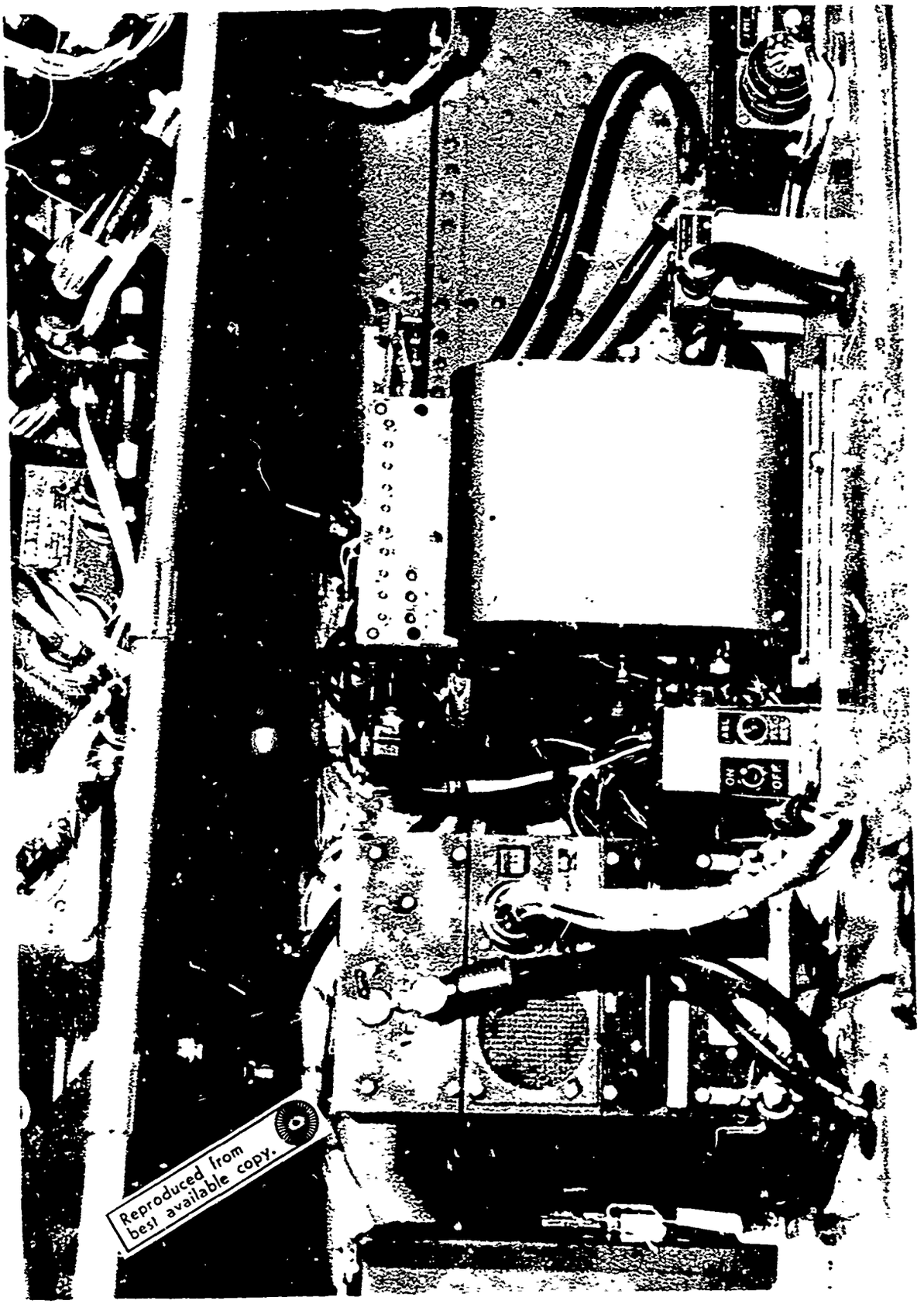

Figure 2. Installation of Recording Oscillograph

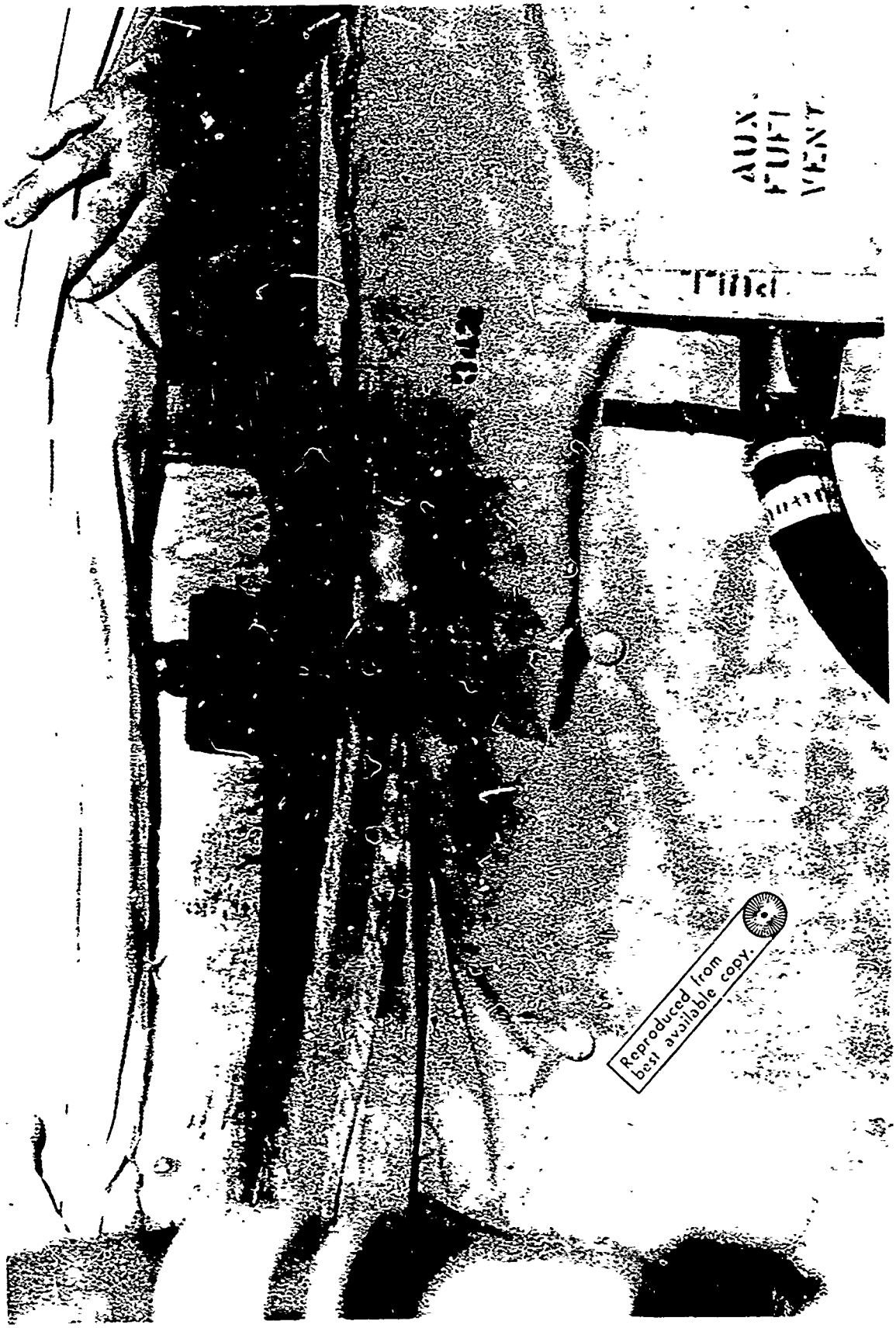

Figure 3. Installation of Vertical Acceleration Transducer

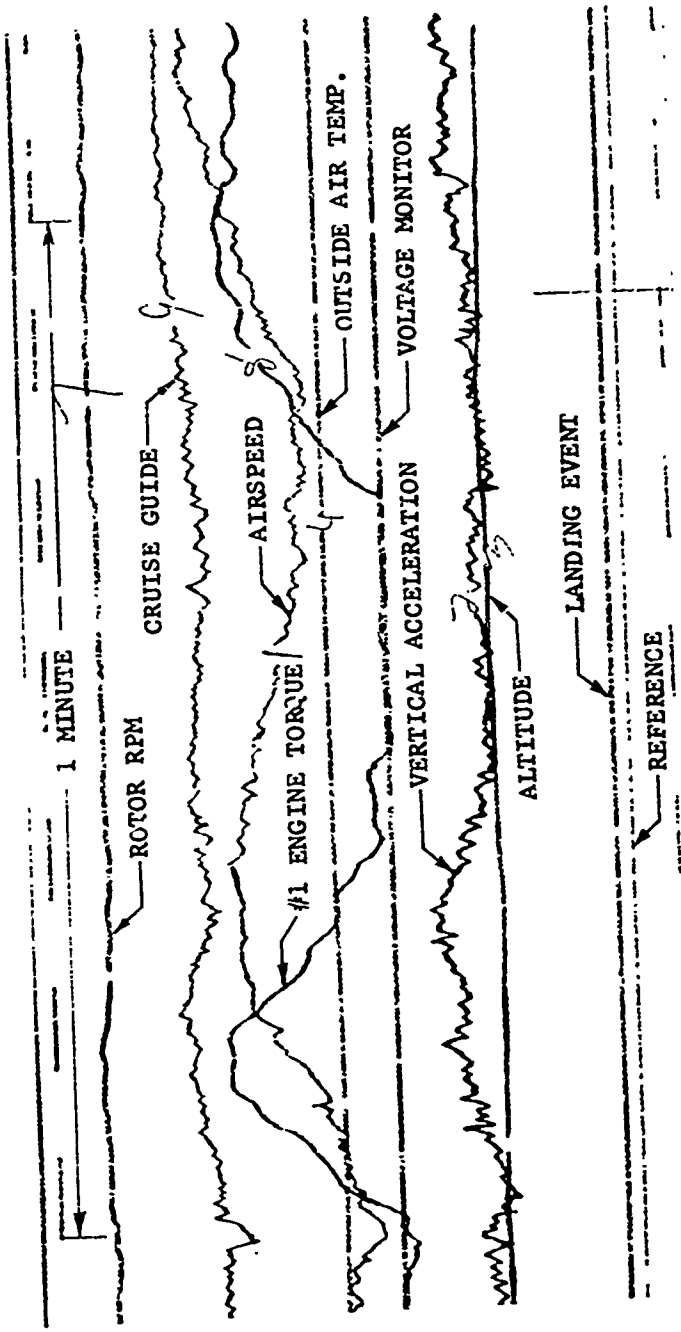

Figure 4. Typical Oscillograph Trace

NAVAL AIR DEVELOPMENT CENTER
JOHNSVILLE
AERO STRUCTURES DEPARTMENT
WARMINSTER, PA. 18974

PILOT FLIGHT REPORT
(To be completed after flight)

TO THE PILOT: This helicopter is equipped with a flight recorder which automatically produces a record of airspeed, altitude, normal acceleration, and other flight environment conditions. This information will contribute to improvement of structural design requirements and fatigue life determination. The following information is required for proper evaluation of the recorded data. Your assistance is greatly appreciated.

DATE:_____ TAKE-OFF TIME:_____

SQUADRON:_____ A/C MODEL:_____ BUNO:_____

1. Description of mission including any unusual maneuvers: (ie. incidents of blade stall, auto rotation, engine failure, turbulence, hard landings, etc.)

2. Gross Weight Information

Gross Weight at Take-Off_____

Stop No.	Weight of Fuel Added	Weight of Troops and/or Cargo Loaded	Weight of Troops and/or Cargo Unloaded
1			
2			
3			
4			

Gross Weight at Landing_____

Figure 5. Pilot Flight Report Form

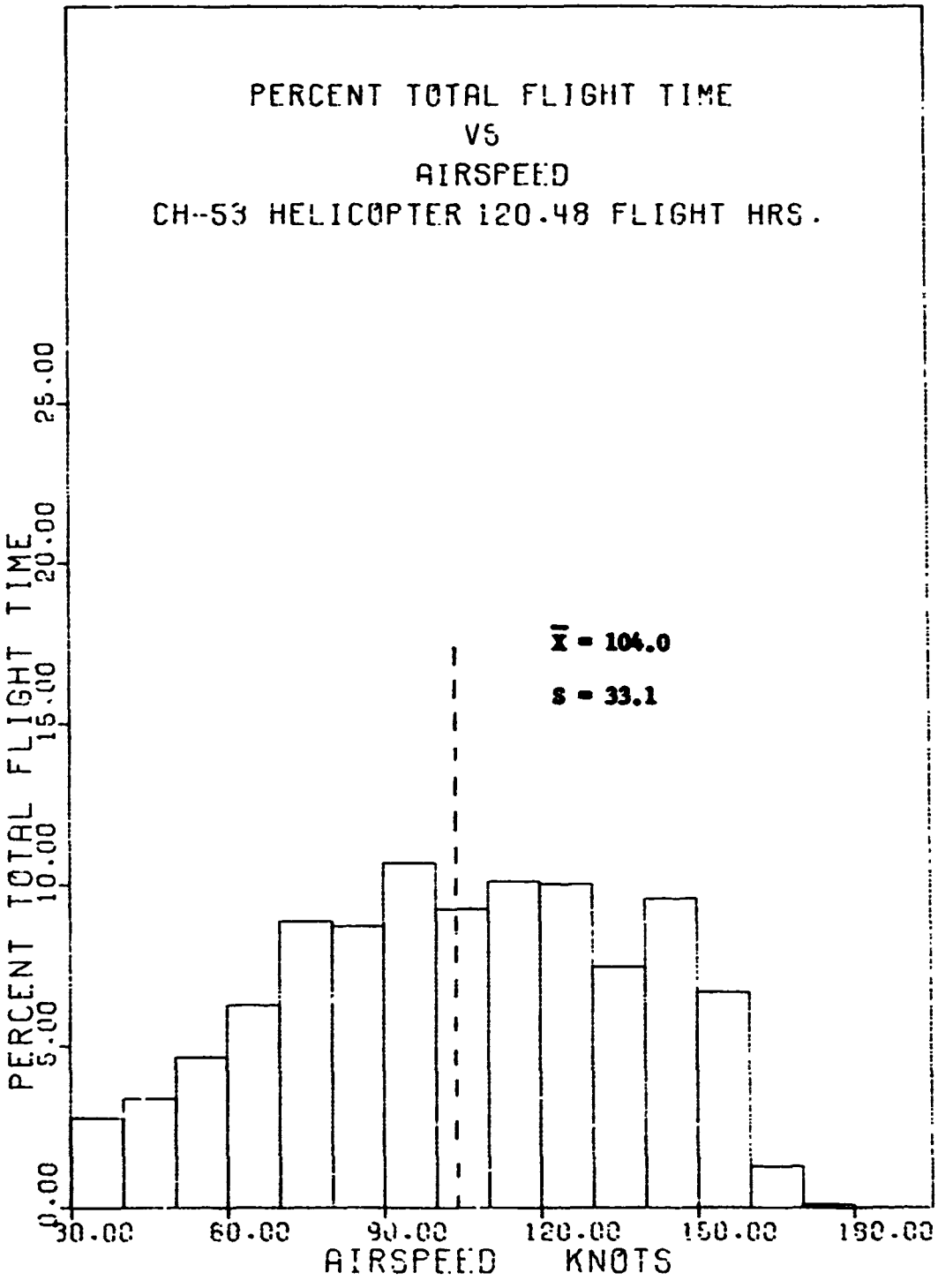

Figure 6. Percent Total Flight Time vs. Airspeed

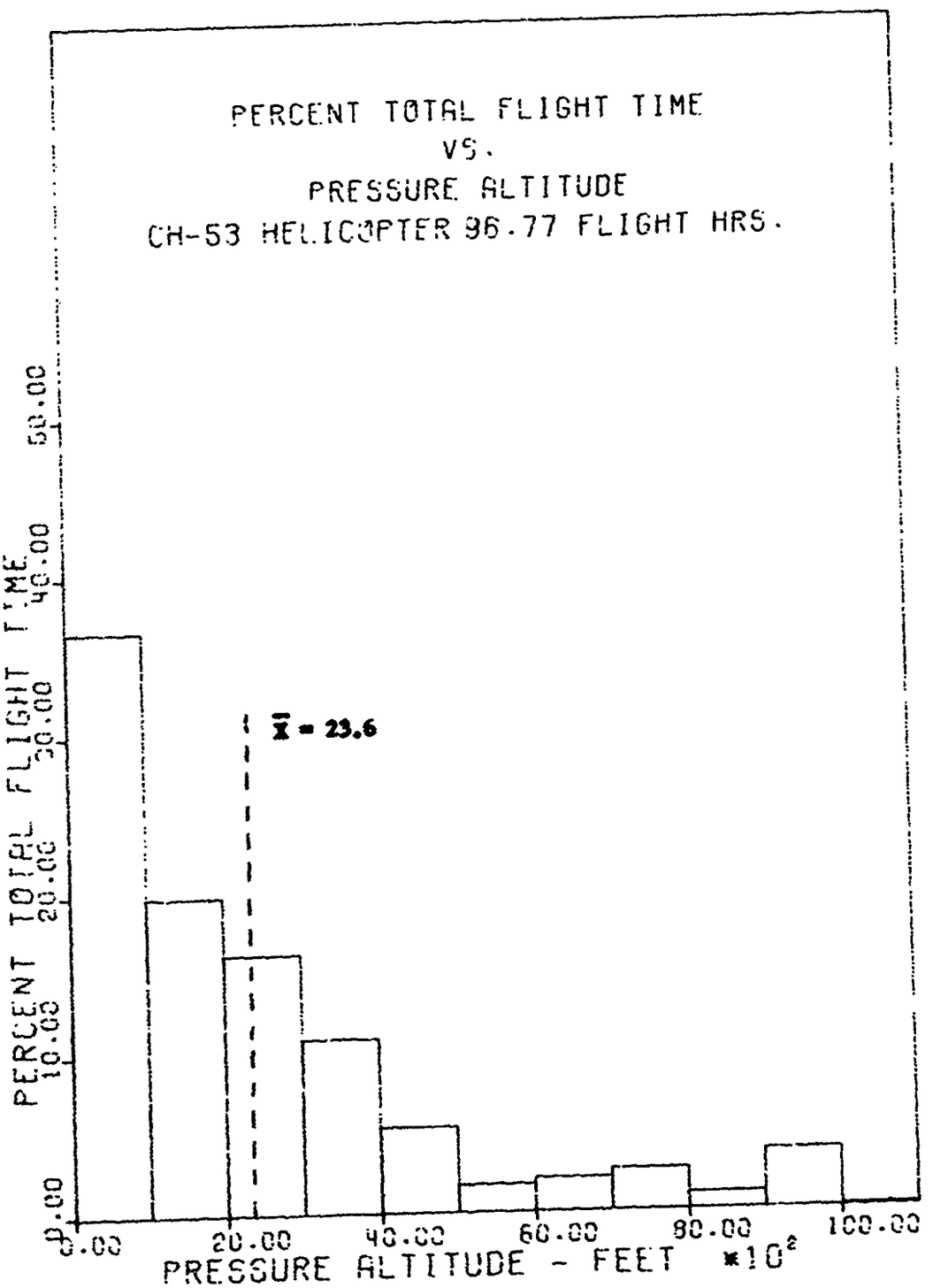

Figure 7. Percent Total Flight Time vs. Pressure Altitude

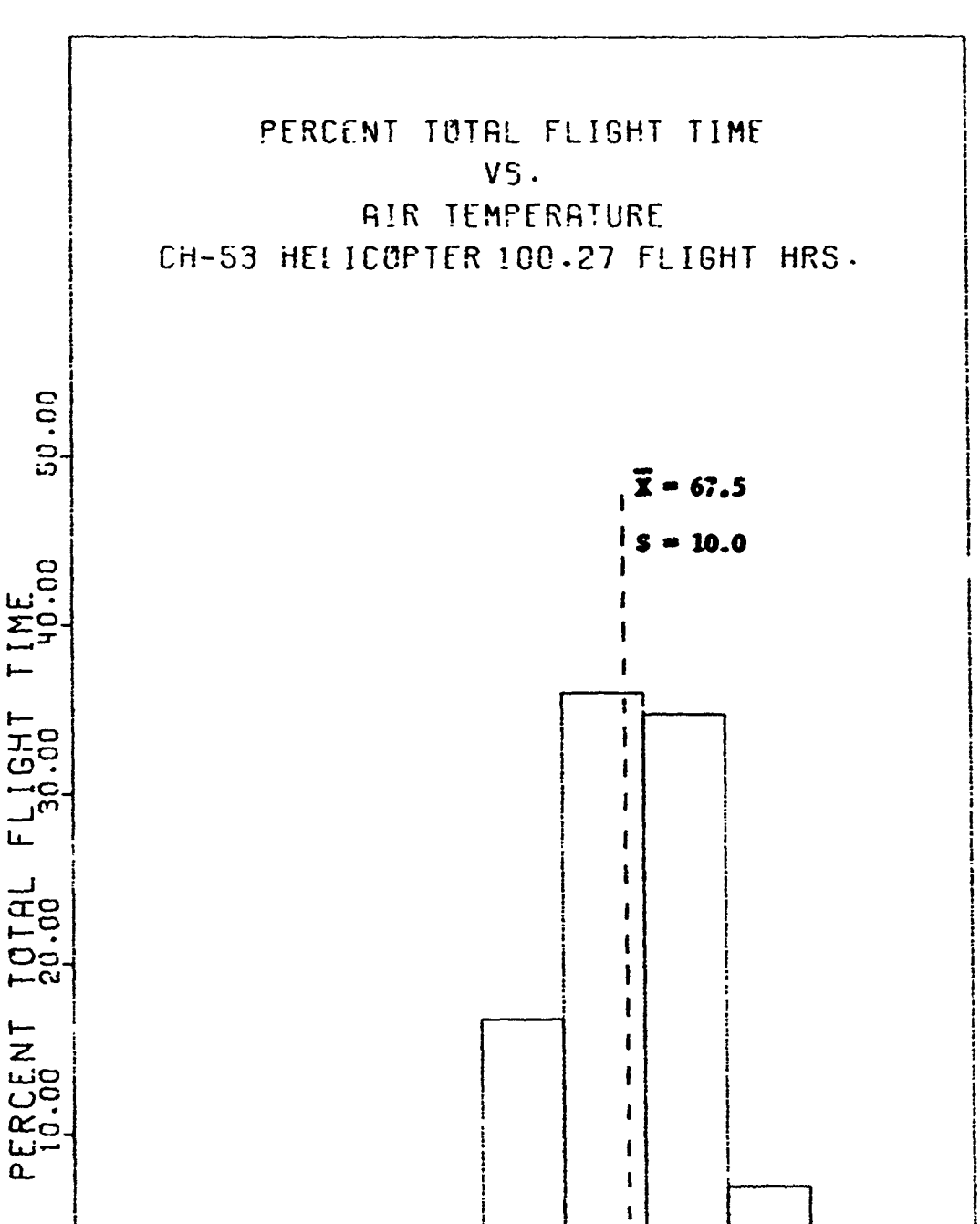

Figure 8. Percent Total Flight Time vs. Air Temperature

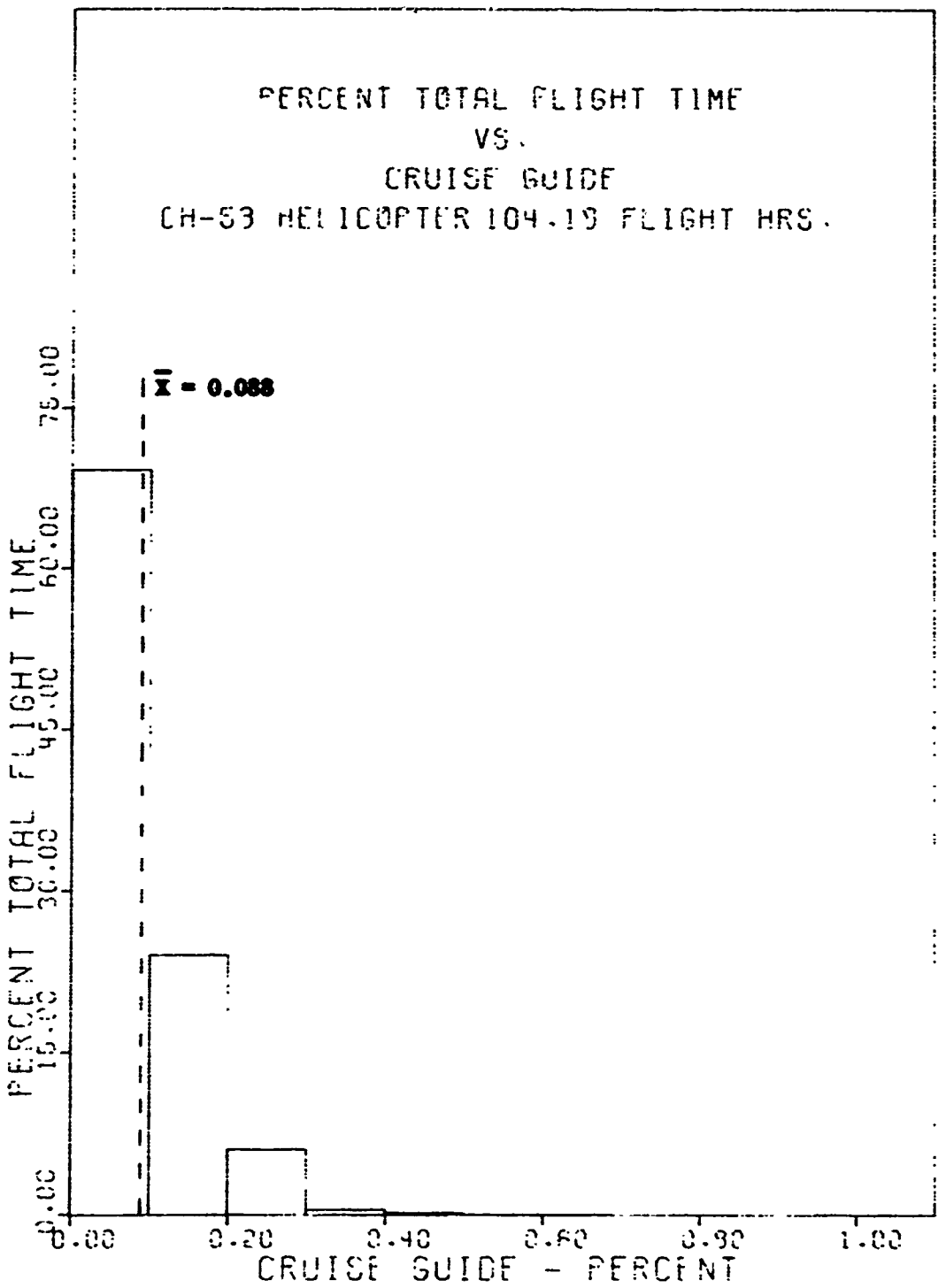

Figure 9. Percent Total Flight Time vs. Cruise Guide

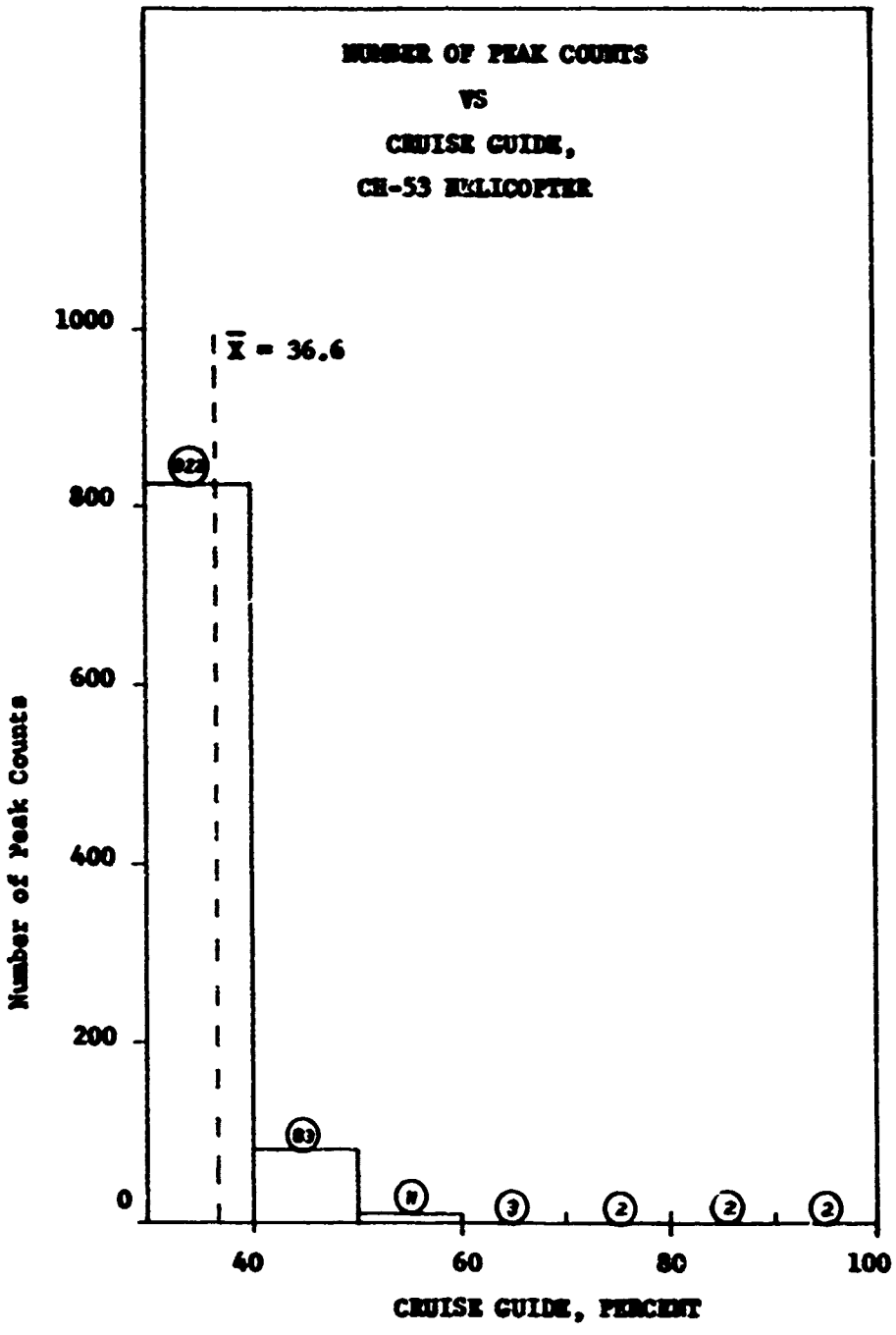

Figure 10. Number of Peak Counts vs. Cruise Guide

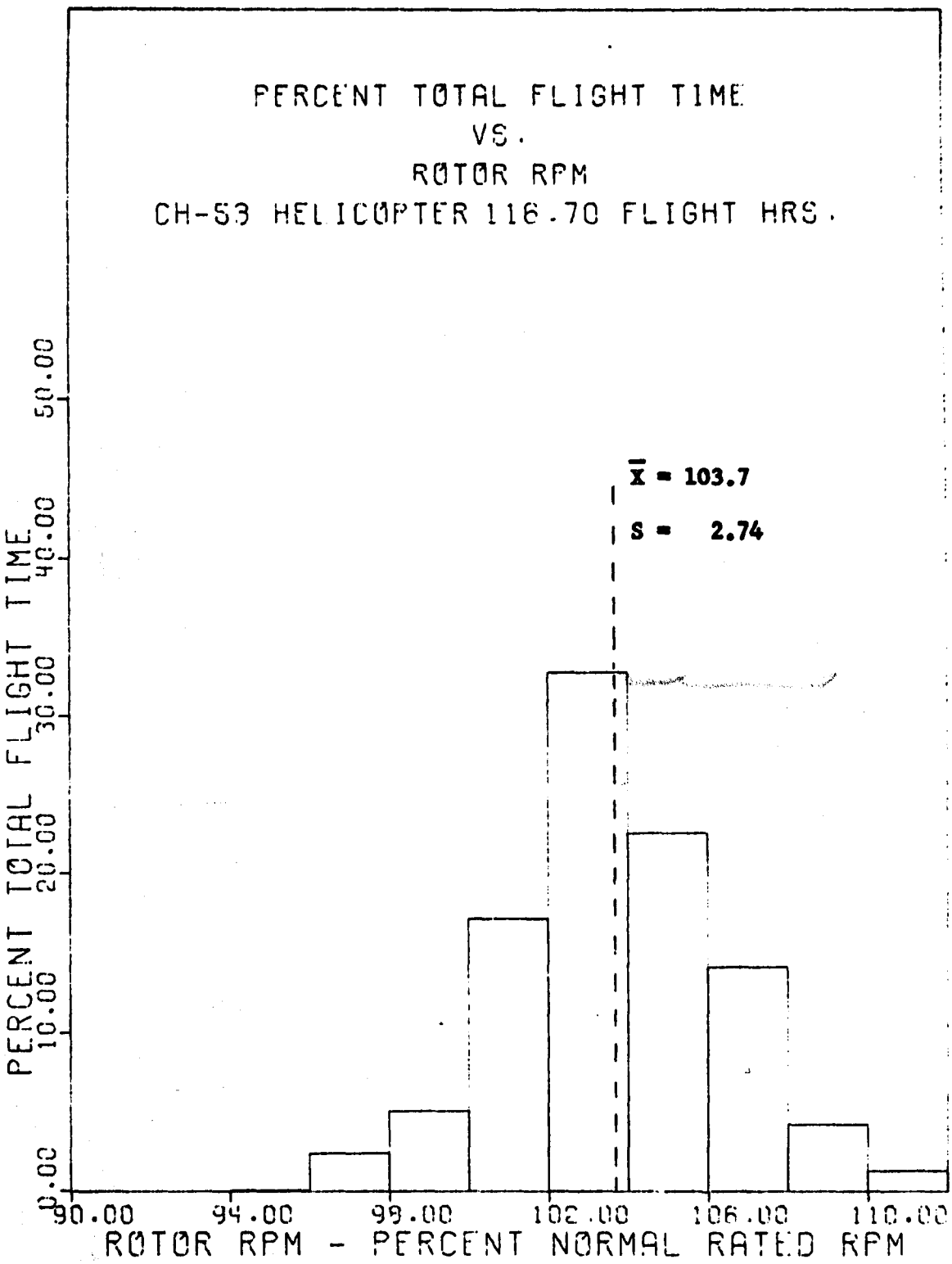

Figure 11. Percent Total Flight Time vs. Rotor RPM

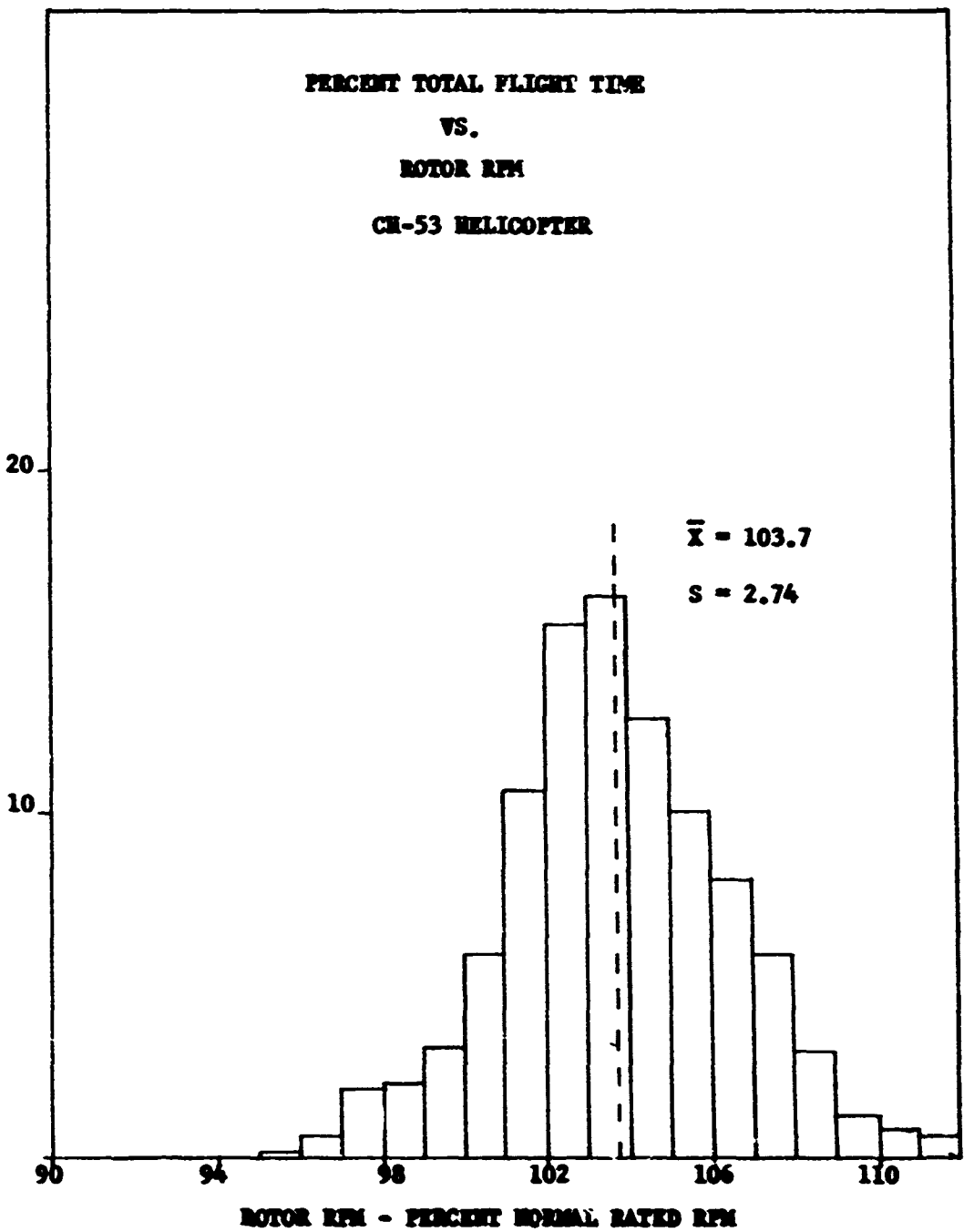

Figure 12. Percent Total Flight Time vs. Rotor RPM

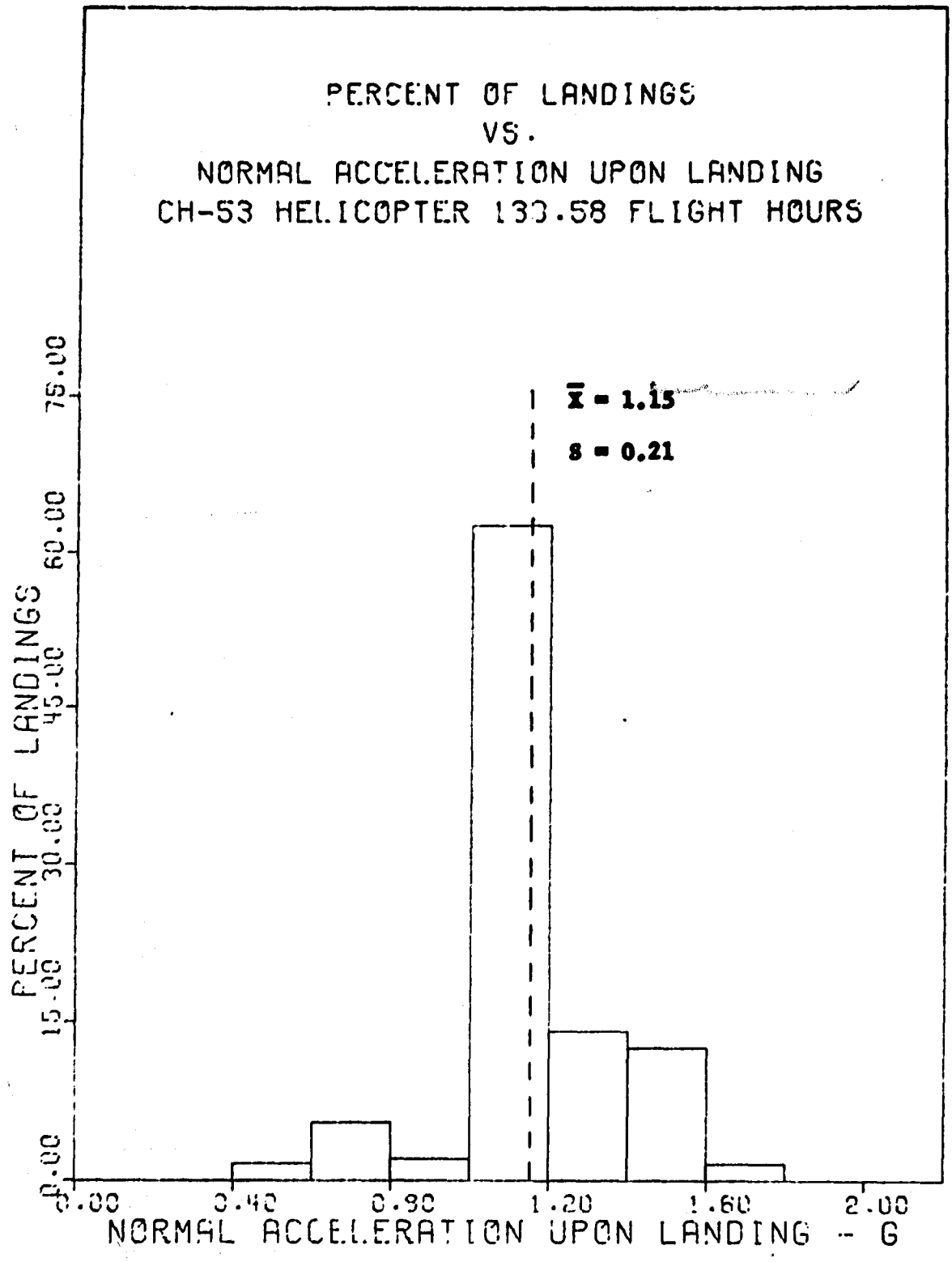

Figure 13. Percent of Landings vs. Normal Acceleration upon Landing

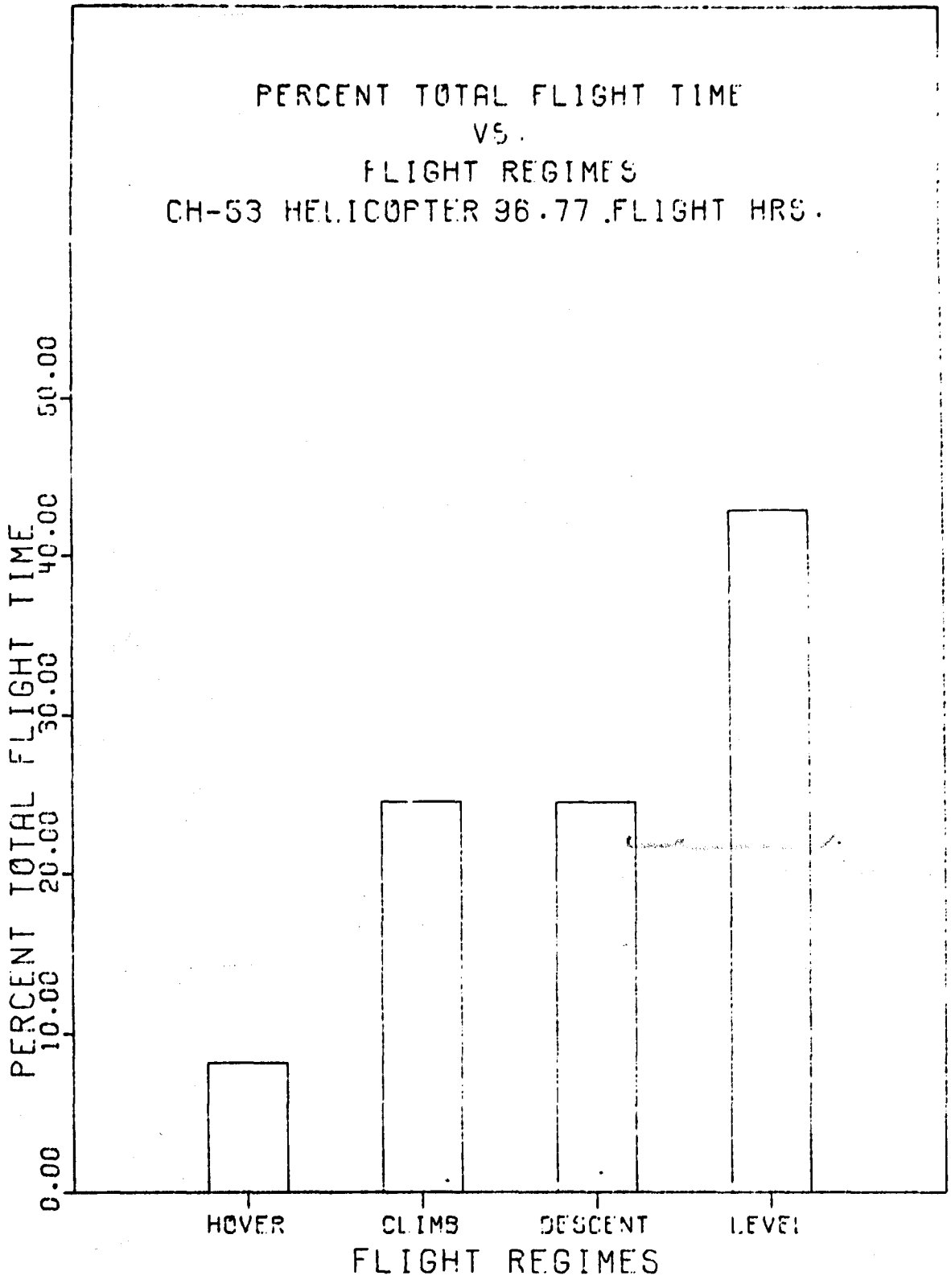

Figure 14. Percent Total Flight Time vs. Flight Regimes

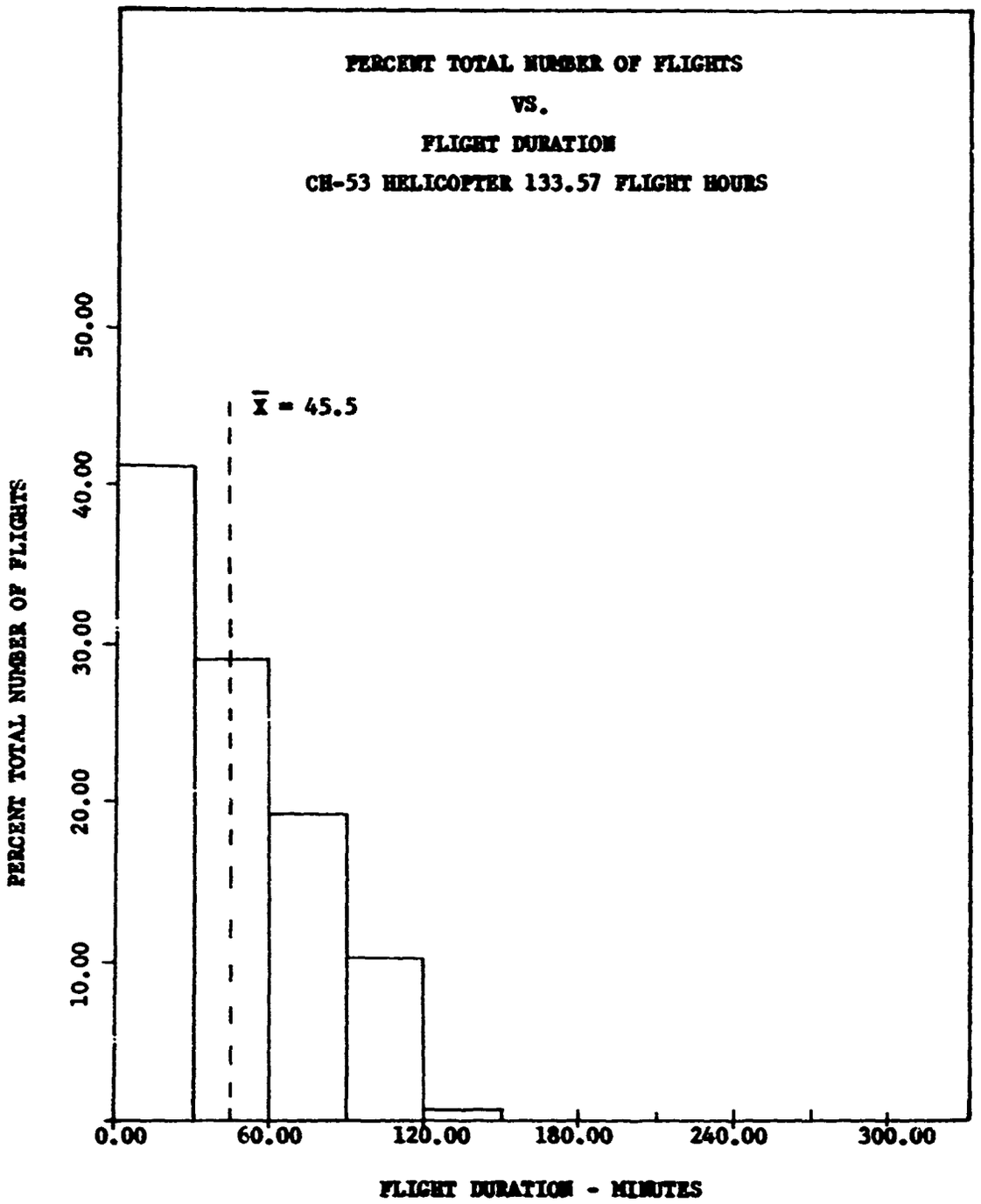

Figure 15. Percent Total Flight Time vs. Flight Duration

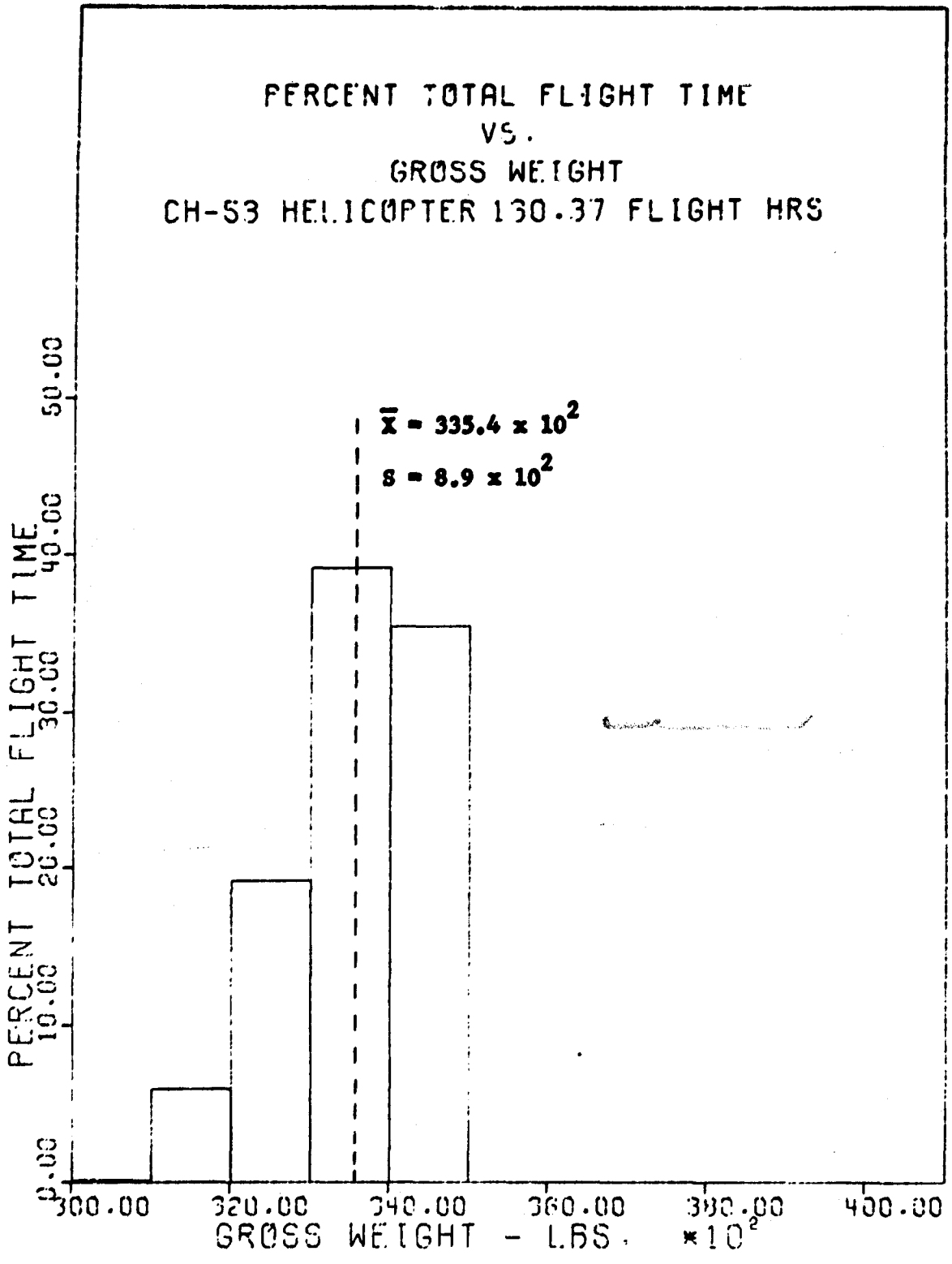

Figure 16. Percent Total Flight Time vs. Gross Weight

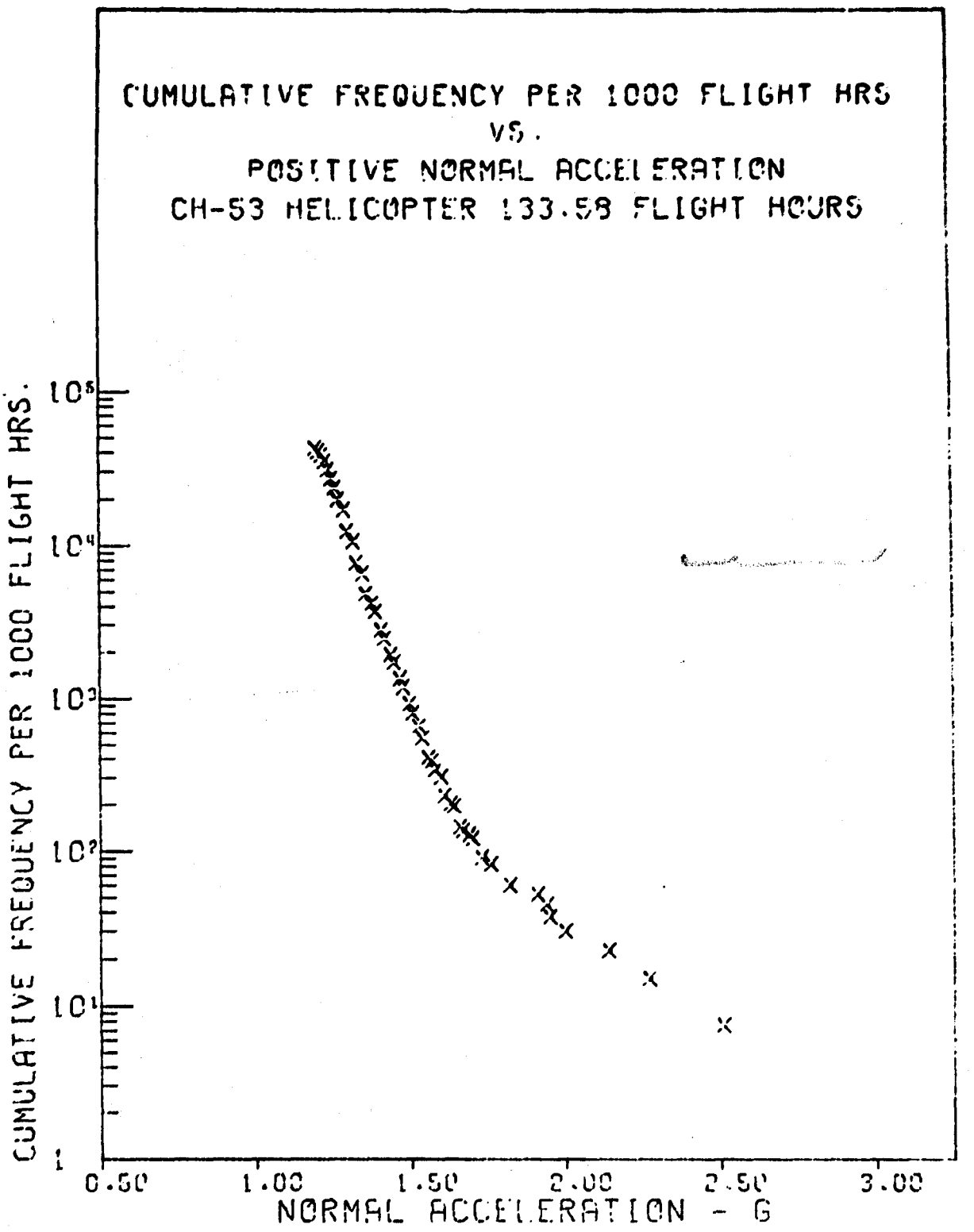

Figure 17. Cumulative Frequency per 1000 Flight Hrs. vs. Positive Normal Acceleration

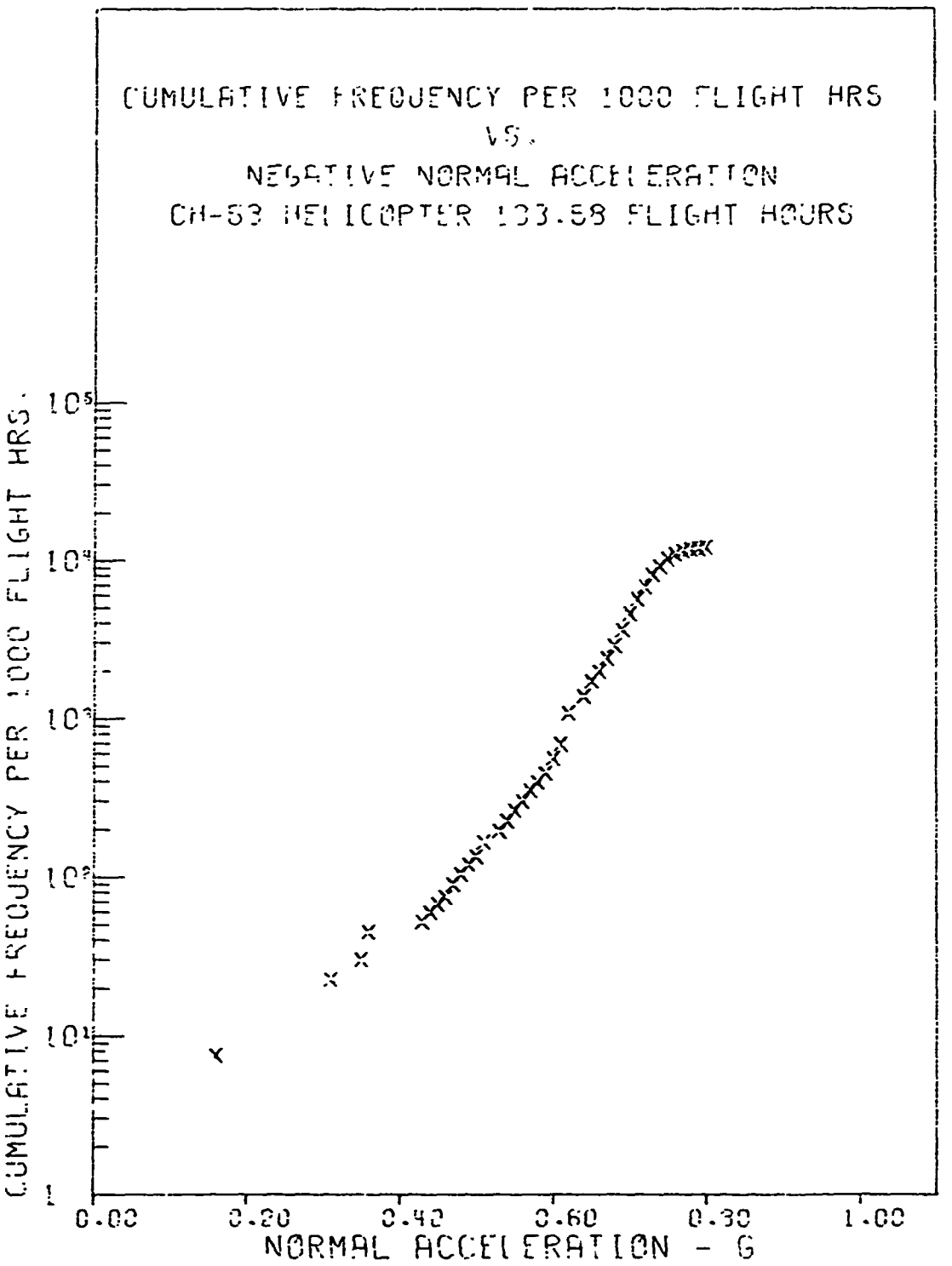

Figure 18. Cumulative Frequency per 1000 Flight Hrs. vs. Negative Normal Acceleration

APPENDIX A

LISTING OF DATA POINTS,

CRUISE GUIDE OCCURRENCES EXCEEDING 30%

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.301	168	2396	.401	168.2	1.33
.302	158	3380	.405	181.1	1.25
.304	158	3325	.398	179.7	1.04
.304	144	1278	.397	185.3	1.35
.305	158	3425	.397	181.5	1.0.
.306	158	3302	.396	180.6	1.00
.306	157	3403	.397	181.8	.97
.306	151	5571	.381	181.4	1.00
.306	157	3240	.401	179.6	1.26
.306	154	5442	.386	181.5	1.00
.306	156	3313	.404	180.1	.95
.306	161	5375	.396	182.2	.96
.306	159	5878	.391	182.0	.96
.307	157	1752	.384	189.9	1.24
.307	157	3336	.399	181.0	.95
.307	156	5451	.387	181.2	1.01
.307	161	3250	.401	180.2	1.00
.307	161	3206	.402	180.0	.85
.308	156	3308	.399	179.6	.99
.308	161	3305	.394	181.2	.90
.308	153	3296	.402	180.3	1.13
.308	154	3349	.402	180.4	1.05
.308	148	1305	.381	180.9	1.08
.308	155	3271	.401	180.1	1.01
.308	159	5809	.390	182.2	.98
.309	157	5717	.393	182.2	.96
.309	156	5726	.396	181.9	.99
.309	155	3355	.400	180.6	1.02
.309	159	5815	.397	181.7	.97
.309	157	2290	.400	180.7	.93
.310	157	5717	.391	182.2	.98
.310	155	3259	.400	180.4	1.01
.310	158	5432	.396	182.0	.98
.310	150	993	.374	181.1	1.08
.310	156	5277	.394	182.0	.99
.310	154	3285	.405	180.8	1.11
.310	152	5794	.395	182.5	1.05
.311	159	3441	.392	181.4	1.01
.311	157	4866	.395	182.1	.98
.311	155	3493	.396	180.4	.97
.311	160	3441	.391	181.7	1.01
.311	161	4043	.393	182.3	.99
.311	159	5788	.392	182.5	.96
.311	152	3296	.401	180.6	1.01
.311	161	3462	.402	181.0	1.03
.311	160	3288	.403	181.5	1.00
.311	159	3483	.399	180.1	1.05
.311	150	5359	.391	181.7	1.06
.311	159	3324	.395	180.2	.98
.311	158	3355	.397	180.6	1.01

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.311	160	2731	.395	180.4	.97
.311	159	3339	.398	180.5	.98
.312	160	3467	.401	181.0	.91
.312	154	3264	.404	180.4	.86
.312	156	3328	.402	180.8	1.05
.312	164	3360	.396	181.7	.96
.312	159	3247	.401	179.3	.94
.312	159	3366	.402	179.5	.87
.312	157	3472	.400	180.4	1.04
.312	154	3302	.400	180.6	.93
.312	154	3366	.405	180.6	.95
.312	157	3301	.401	181.1	.99
.312	157	3343	.403	181.1	1.09
.312	155	6232	.391	182.9	1.02
.312	157	5356	.394	182.0	.90
.312	163	3307	.400	180.5	.97
.312	158	3348	.394	178.8	1.05
.312	159	3370	.399	180.8	1.02
.312	160	3317	.399	181.0	1.05
.312	156	3338	.403	180.9	1.02
.313	159	5993	.393	182.2	.99
.313	156	3312	.402	180.6	1.06
.313	159	3248	.402	180.6	1.05
.313	159	3260	.400	180.4	1.04
.313	159	4262	.394	182.2	.75
.313	155	3462	.400	180.9	1.05
.313	157	3238	.403	180.6	1.02
.313	159	6074	.388	182.4	.96
.313	144	898	.406	200.8	1.34
.313	159	3269	.403	180.9	1.00
.313	150	1361	.386	180.1	.86
.313	155	6222	.389	182.3	1.02
.313	164	2757	.404	180.8	.95
.313	160	3348	.409	181.1	1.03
.313	156	3334	.396	180.1	.91
.313	158	3377	.398	180.8	1.02
.313	162	3270	.403	180.4	1.02
.313	159	3526	.399	180.4	.98
.314	161	3343	.404	180.7	1.09
.314	162	3364	.405	181.2	.97
.314	159	3425	.397	181.5	1.06
.314	155	3309	.407	181.3	1.05
.314	160	3457	.403	180.3	1.22
.314	155	3478	.398	180.5	.97
.314	166	2229	.408	183.1	1.02
.314	161	3413	.402	181.0	1.00
.314	158	3296	.399	180.8	1.05
.314	156	3296	.404	180.6	1.00
.314	162	3509	.402	182.1	1.00
.314	155	3264	.401	180.6	.93

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.314	162	4499	.392	181.2	.90
.314	159	3451	.399	180.6	.94
.314	160	3366	.400	180.6	.98
.314	158	6248	.385	182.4	.97
.314	162	3227	.402	180.7	1.01
.314	159	3472	.397	181.1	.93
.314	160	3462	.399	182.0	1.24
.314	161	3258	.404	180.5	1.02
.314	156	3333	.400	181.1	1.05
.314	160	3418	.401	181.1	.86
.314	162	3385	.408	181.4	1.02
.315	153	3264	.399	180.8	1.04
.315	162	3499	.402	180.6	.97
.315	160	3317	.399	180.8	1.02
.315	161	3445	.401	180.6	1.23
.315	154	3328	.402	180.6	1.08
.315	160	3328	.402	180.8	1.01
.315	158	5338	.401	182.3	1.03
.315	156	5720	.393	182.2	1.02
.315	158	3335	.398	179.6	1.05
.315	154	3250	.401	180.1	1.00
.315	153	3375	.394	181.9	.95
.315	159	3185	.399	180.4	.96
.315	159	3504	.405	181.9	1.00
.315	153	3366	.399	180.6	.97
.315	158	3164	.400	180.6	1.08
.315	161	3482	.404	181.1	1.03
.315	159	3258	.404	180.9	1.09
.315	159	3365	.403	180.7	1.03
.315	160	3290	.404	181.1	.96
.315	161	2698	.406	181.1	.93
.315	158	3339	.402	179.6	1.06
.315	150	344	.380	182.2	1.05
.315	159	5225	.398	182.1	.98
.315	158	5863	.399	182.3	1.05
.315	160	3574	.399	181.0	.88
.315	161	3456	.402	181.0	1.00
.315	159	5700	.395	182.1	.96
.315	158	3359	.402	181.1	.88
.316	154	4645	.396	181.7	1.01
.316	157	5375	.393	182.0	.97
.316	159	4914	.402	181.9	1.00
.316	158	5740	.394	182.0	.98
.316	158	6178	.390	182.0	.98
.316	163	3569	.400	182.0	.95
.316	162	3587	.394	182.2	.98
.316	163	2409	.402	181.3	.99
.316	161	3301	.397	181.2	.91
.316	161	3354	.406	181.1	1.09
.316	152	1296	.381	181.0	1.02

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.316	153	3363	.407	181.3	1.05
.316	154	5322	.394	181.8	1.05
.316	156	5367	.394	182.0	1.09
.316	139	846	.354	189.3	1.43
.316	157	3264	.402	180.8	1.21
.316	158	5749	.395	182.3	.99
.316	157	3445	.405	180.3	.98
.316	160	3328	.401	180.8	1.01
.316	159	6083	.392	182.3	1.06
.316	156	892	.345	182.1	1.25
.316	161	3628	.405	181.7	.94
.316	159	2548	.401	181.0	1.02
.316	161	3345	.401	179.9	1.01
.317	160	3676	.396	182.0	.93
.317	159	3194	.404	180.7	1.00
.317	160	3162	.403	180.9	1.05
.317	160	3354	.403	180.3	1.01
.317	155	5988	.397	182.4	1.05
.317	161	3342	.410	181.2	.99
.317	161	3373	.409	182.0	.93
.317	162	3349	.398	181.9	1.01
.317	162	3243	.404	180.4	1.01
.317	156	3264	.401	180.8	1.00
.317	164	3380	.400	181.3	.99
.317	163	3305	.405	181.1	.95
.317	149	382	.379	181.3	1.23
.317	165	3473	.395	181.7	.92
.317	152	7876	.326	191.0	1.27
.317	158	3312	.403	181.3	1.00
.317	159	3333	.404	181.1	1.22
.317	157	3265	.397	181.1	1.10
.318	163	3331	.407	181.9	1.01
.318	165	3542	.405	180.6	.94
.318	153	5521	.399	181.9	1.01
.318	157	6002	.390	182.3	.98
.318	165	2860	.402	181.3	1.02
.318	154	3303	.396	180.1	1.08
.318	159	3314	.409	180.8	1.04
.318	159	3472	.400	180.7	.96
.318	162	4636	.396	182.2	1.03
.318	158	6109	.390	181.9	.96
.318	136	1116	.414	183.9	1.33
.318	162	3450	.404	182.0	1.02
.318	161	3353	.407	181.6	.94
.318	161	3542	.395	181.6	1.00
.318	154	3393	.400	180.3	.93
.319	162	3316	.402	180.9	1.00
.319	157	3263	.402	181.3	.96
.319	157	3313	.401	180.8	.98
.319	166	3355	.400	180.9	.87

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.319	159	3291	.405	180.2	.89
.319	158	5751	.394	182.2	1.00
.319	167	3440	.400	181.5	1.08
.319	165	3354	.401	181.1	.91
.319	161	3333	.401	180.9	.91
.319	162	3525	.406	182.5	1.02
.319	159	3182	.397	179.8	1.05
.319	158	3330	.402	179.8	1.07
.319	160	3897	.398	182.0	1.03
.319	159	3866	.400	182.0	1.00
.319	134	808	.465	198.4	1.24
.319	162	3306	.402	180.8	1.00
.319	155	3285	.401	180.6	1.01
.319	160	3402	.399	180.5	1.06
.319	160	5320	.402	182.2	.97
.320	161	4374	.411	187.2	1.06
.320	165	2312	.408	182.0	.99
.320	154	3398	.399	180.6	1.25
.320	160	3355	.400	180.6	1.10
.320	158	3366	.402	181.1	1.07
.320	161	3343	.409	180.3	1.03
.320	155	3386	.406	180.5	1.08
.320	163	3374	.413	181.3	1.05
.320	162	3435	.400	181.4	.97
.320	159	3276	.401	180.5	1.05
.320	163	3457	.398	181.4	1.03
.320	159	3457	.398	180.5	.93
.320	160	3435	.401	180.5	.96
.320	157	3315	.397	179.1	1.01
.320	157	3445	.402	181.0	1.00
.320	159	3499	.401	181.2	1.02
.320	158	3467	.401	181.4	1.07
.320	150	420	.387	180.6	1.14
.320	159	3199	.403	181.1	.89
.320	158	5825	.384	182.1	.94
.320	164	4561	.400	181.9	.98
.320	157	3419	.399	180.7	1.04
.320	162	3334	.399	180.9	.96
.320	164	3416	.399	182.2	.85
.320	159	5206	.396	181.9	1.01
.320	161	4473	.401	183.6	1.06
.321	152	3440	.406	180.7	1.01
.321	157	3297	.401	180.3	1.10
.321	154	6215	.384	182.3	1.00
.321	155	5979	.393	182.3	.89
.321	162	3585	.405	182.1	.95
.321	159	3328	.399	180.8	1.10
.321	158	3563	.405	181.9	.96
.321	153	3295	.405	181.1	1.25
.321	161	3348	.406	180.9	1.00

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.321	160	3370	.405	180.8	1.04
.321	158	5398	.397	182.2	1.01
.321	155	3291	.402	181.3	1.05
.321	152	3440	.403	180.7	1.00
.321	158	3330	.399	179.4	.98
.322	158	3316	.397	178.9	1.03
.322	159	3446	.398	180.5	.98
.322	165	3361	.401	180.8	.87
.322	162	2692	.405	181.1	1.04
.322	158	3334	.401	180.2	1.02
.322	157	3313	.401	179.9	1.08
.322	161	3248	.402	180.4	.98
.322	161	3238	.405	180.0	1.01
.322	158	3302	.396	180.6	1.06
.322	153	5262	.394	182.0	.95
.322	154	5240	.396	182.0	1.04
.322	161	4840	.401	182.4	.93
.322	159	3245	.399	179.8	1.00
.322	163	4518	.395	182.0	1.01
.322	153	3402	.404	180.8	1.06
.322	158	3876	.401	182.3	.91
.322	159	3296	.402	180.6	1.04
.322	164	2403	.401	181.0	1.01
.323	140	885	.444	200.6	1.42
.323	159	4228	.396	181.7	.95
.323	158	3270	.402	180.6	1.04
.323	150	1249	.377	180.6	1.10
.323	162	3247	.404	180.7	.99
.323	150	1393	.369	180.7	1.09
.323	157	5483	.403	182.4	1.02
.323	157	916	.383	180.8	.98
.323	155	3457	.400	180.5	1.04
.323	161	3767	.401	182.0	1.01
.323	154	5232	.395	181.8	1.04
.323	157	3402	.402	180.6	1.04
.323	159	3638	.404	181.9	.99
.323	165	2788	.402	181.0	.97
.323	160	7837	.327	189.3	1.23
.323	150	395	.375	183.1	1.00
.323	158	3441	.396	180.2	1.03
.323	166	2784	.408	181.5	.98
.324	157	5717	.385	182.4	.97
.324	160	3215	.398	181.1	1.06
.324	159	3290	.404	180.7	1.04
.324	163	3472	.404	180.9	.96
.324	161	3365	.404	181.8	1.01
.324	158	5628	.386	182.0	1.02
.324	154	5788	.394	182.0	.96
.324	158	5806	.396	181.9	1.02
.324	152	5509	.396	182.1	1.02

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.324	158	3316	.406	180.8	.92
.324	154	3461	.404	180.7	1.11
.324	163	3205	.404	181.1	1.03
.324	156	3333	.404	180.7	1.01
.325	160	4487	.405	184.0	1.01
.325	158	3275	.402	180.8	1.00
.325	164	3757	.401	182.1	.93
.325	157	6199	.390	182.1	.98
.325	160	3531	.406	182.6	1.05
.325	165	3423	.405	182.2	1.00
.325	161	3333	.403	180.3	1.02
.325	158	3340	.395	179.8	.97
.325	156	3244	.404	180.1	1.08
.326	163	3517	.404	181.6	1.05
.326	164	3338	.405	181.6	.98
.326	161	3302	.403	180.4	.97
.326	163	3227	.403	180.6	1.02
.326	160	3472	.396	181.9	1.03
.326	163	4525	.391	181.1	.94
.326	159	3322	.398	182.4	1.02
.326	159	5369	.397	182.4	1.04
.326	158	6180	.388	182.0	.95
.326	158	3244	.403	180.3	1.12
.326	131	950	.497	198.9	1.30
.327	156	3398	.401	181.3	1.02
.327	162	3487	.408	182.9	.86
.327	162	4438	.400	182.2	1.01
.327	150	1824	.376	180.6	1.08
.327	160	3451	.399	181.1	1.00
.327	160	3247	.407	180.1	.98
.327	159	3245	.402	180.0	1.00
.327	157	1106	.384	181.0	.99
.327	148	5367	.392	181.6	1.03
.327	162	3446	.395	181.2	1.00
.327	159	3275	.404	181.7	1.24
.327	158	3531	.396	180.8	.88
.327	160	3349	.404	180.8	1.07
.327	157	3467	.401	181.2	1.01
.327	164	3338	.404	181.7	.97
.327	161	5338	.396	182.3	1.00
.327	160	3263	.406	180.9	1.00
.327	155	3327	.400	180.9	1.12
.327	162	3569	.399	181.5	1.04
.327	162	3536	.400	182.0	.99
.327	157	6050	.390	182.4	.95
.328	160	3311	.406	180.7	.99
.328	161	3515	.406	180.7	.93
.328	162	3446	.398	181.8	.97
.328	160	3435	.401	181.4	1.10
.328	160	3212	.401	180.3	1.05

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.328	159	3223	.398	180.3	1.05
.328	163	3552	.402	182.1	.94
.328	162	3509	.404	181.7	1.01
.328	159	5203	.396	181.9	1.05
.328	161	3757	.399	181.9	1.04
.328	161	4488	.396	182.5	.95
.328	161	3462	.402	181.7	1.00
.328	160	5372	.395	182.5	1.00
.328	162	3338	.405	181.1	1.05
.328	156	3462	.399	181.5	1.05
.328	159	3250	.404	179.5	1.05
.328	154	3430	.402	180.4	1.14
.328	165	2887	.400	181.2	.98
.328	165	2313	.403	181.4	.99
.329	162	3329	.410	179.8	.97
.329	160	3671	.400	182.0	.98
.329	158	5651	.384	182.0	1.00
.329	161	3180	.397	180.5	1.01
.329	155	3253	.402	180.6	1.08
.329	159	5737	.395	181.9	.99
.329	160	3445	.405	181.9	1.05
.329	162	3360	.404	180.8	1.06
.329	161	3306	.402	180.8	.98
.329	159	3355	.405	180.4	.98
.329	159	3334	.400	180.9	1.02
.329	30	2008	.398	193.6	1.34
.329	161	3365	.407	180.5	.88
.329	163	3386	.401	180.9	1.05
.329	159	5526	.392	182.0	1.02
.329	159	3329	.406	179.9	1.05
.329	163	3402	.404	180.4	1.04
.329	163	4732	.402	181.9	.95
.329	159	3296	.402	180.6	1.04
.330	148	5348	.391	181.7	1.14
.330	161	3337	.406	181.5	1.00
.330	160	6016	.388	182.2	.97
.330	158	3665	.400	182.2	1.07
.330	157	3259	.402	180.4	1.10
.330	165	2205	.409	182.3	1.05
.330	162	3343	.400	181.1	1.04
.330	164	3343	.400	180.9	.96
.330	160	3365	.406	180.9	1.02
.330	164	2961	.403	181.4	.94
.330	155	6231	.393	181.5	.89
.330	164	3457	.394	181.3	.94
.330	154	5691	.395	181.9	1.09
.331	158	5889	.390	182.2	1.01
.331	154	5557	.394	181.9	1.05
.331	159	3360	.401	180.6	.91
.331	160	5429	.396	181.9	.98

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.331	159	3328	.404	181.0	.95
.331	149	5548	.403	182.6	1.04
.331	157	3344	.405	180.2	1.05
.331	157	3526	.403	181.7	1.09
.331	162	3344	.402	180.9	1.04
.331	164	3046	.403	180.9	.95
.332	151	906	.414	192.3	1.30
.332	159	3402	.402	180.6	1.10
.332	157	3292	.396	181.0	1.02
.332	159	3302	.403	180.2	.98
.332	158	5478	.390	182.2	1.07
.332	156	5809	.391	182.0	.96
.332	160	3450	.404	181.1	.99
.332	154	3365	.403	180.7	.99
.332	161	3493	.400	181.1	.97
.332	162	3001	.402	181.6	1.01
.332	156	3393	.403	180.1	1.02
.332	155	3382	.401	180.3	1.07
.333	160	3352	.408	181.3	1.08
.333	159	3402	.396	180.8	1.00
.333	160	3346	.399	179.7	1.08
.333	160	5421	.394	182.0	.96
.333	150	3483	.399	180.6	.98
.333	165	2952	.400	181.1	.95
.333	159	5648	.385	182.2	1.01
.333	161	5335	.397	182.4	1.02
.333	162	4004	.391	181.6	1.01
.333	156	6071	.390	182.1	1.03
.333	161	2684	.402	180.8	.96
.334	150	315	.380	182.0	1.09
.334	161	5309	.406	182.2	1.00
.334	160	3200	.402	179.9	1.07
.334	163	3189	.401	181.0	.98
.334	161	5343	.399	182.1	.96
.334	162	3924	.398	181.9	.95
.334	162	4164	.400	181.9	1.02
.335	160	5429	.395	182.1	1.00
.335	161	3768	.391	182.1	1.03
.335	159	3563	.405	180.8	1.01
.335	154	5297	.391	181.9	1.01
.335	157	3419	.399	181.7	1.08
.335	161	5432	.391	182.6	.96
.335	158	5409	.396	181.9	1.08
.335	163	2753	.397	180.7	.98
.335	163	3698	.397	182.2	.97
.335	131	816	.465	197.6	1.24
.335	157	3333	.401	180.9	1.01
.336	161	3265	.400	180.3	.95
.336	158	5708	.386	181.8	.99
.336	159	3361	.398	180.5	1.01

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.336	159	4844	.402	181.9	.98
.336	155	3370	.395	180.8	1.04
.336	160	5543	.395	182.1	.98
.336	161	3327	.406	181.3	.93
.336	162	2692	.406	180.6	1.01
.336	159	5489	.394	182.0	1.00
.336	159	4851	.398	182.0	1.03
.336	158	4863	.394	182.0	1.04
.336	157	6250	.386	182.2	.97
.337	156	884	.349	182.1	1.10
.337	163	4044	.397	182.2	.95
.337	158	3258	.403	181.1	1.05
.337	163	3482	.403	181.2	.97
.337	160	5560	.395	182.7	1.02
.337	162	3328	.404	180.8	1.06
.337	162	3349	.402	181.2	.96
.337	160	3381	.399	181.2	.97
.337	160	3380	.403	181.3	1.01
.338	160	3334	.402	180.6	.96
.338	158	5797	.396	182.0	1.05
.338	161	4482	.397	182.0	1.02
.338	156	3472	.404	181.4	1.01
.338	160	3343	.404	180.7	.97
.338	137	922	.444	200.7	1.31
.338	161	3714	.395	182.2	1.05
.338	165	2874	.405	181.8	1.01
.338	156	3243	.402	180.6	1.03
.338	159	4323	.396	182.7	.93
.338	164	2904	.398	180.8	.99
.338	160	3338	.406	181.3	1.04
.338	161	3649	.406	182.2	.96
.338	165	2723	.402	182.1	1.01
.338	155	3344	.402	180.7	1.09
.338	165	3366	.400	181.7	.92
.339	157	6080	.385	181.6	.97
.339	163	3714	.400	181.8	.92
.339	154	4835	.401	186.3	1.17
.339	160	3275	.401	180.6	.97
.339	162	3467	.402	181.7	1.09
.339	154	3204	.404	180.4	1.02
.339	165	2904	.398	181.0	1.01
.339	154	3334	.395	181.0	.96
.339	161	3430	.399	81.7	.98
.339	157	3477	.408	180.6	1.02
.339	162	5400	.399	182.6	1.02
.339	159	5432	.394	182.4	1.00
.339	162	3366	.399	181.9	.94
.339	156	3375	.401	181.1	.95
.339	156	3301	.403	181.1	1.02
.339	162	3525	.404	180.9	.93

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.340	159	5440	.393	182.5	.92
.340	161	3253	.401	180.8	1.02
.340	159	6020	.394	182.6	1.03
.340	161	3156	.406	181.1	1.06
.340	162	3354	.404	180.9	1.01
.340	161	4165	.404	182.4	1.07
.340	161	3301	.404	180.9	1.27
.340	162	3774	.408	182.7	1.02
.340	156	687	.358	182.5	1.11
.340	161	3460	.405	181.0	1.00
.340	158	3445	.407	181.6	1.01
.341	159	3239	.404	179.5	1.05
.341	157	3477	.403	180.6	1.04
.341	156	893	.347	182.4	1.20
.341	158	3440	.406	181.2	1.01
.341	165	2313	.401	181.6	1.04
.341	163	2718	.398	181.0	.90
.341	162	3331	.408	181.5	1.05
.341	159	3185	.402	180.6	1.12
.342	162	3504	.406	181.8	.98
.342	162	4519	.392	180.9	.97
.343	161	3489	.398	181.6	.90
.343	161	5452	.395	182.3	.99
.343	161	5338	.395	182.5	1.00
.343	161	3370	.402	180.8	1.10
.343	158	3402	.406	180.2	.93
.343	157	3526	.400	181.9	1.08
.343	158	5221	.392	181.8	1.06
.344	159	5406	.402	182.3	.98
.344	165	3381	.399	180.8	.98
.344	161	3343	.398	181.4	.97
.344	77	1906	.401	182.8	1.24
.344	158	3521	.403	181.6	1.07
.344	162	3310	.402	181.2	.97
.344	154	3402	.402	180.6	1.06
.345	160	5557	.390	182.2	.97
.345	155	5206	.397	182.0	1.06
.345	162	3708	.404	182.4	.95
.345	152	3241	.398	178.9	1.02
.345	158	6004	.388	182.0	1.00
.345	161	5429	.396	182.3	.97
.345	164	2872	.398	181.0	1.00
.345	149	1942	.374	181.3	1.17
.346	160	3343	.398	181.1	1.11
.346	162	3461	.403	180.9	1.07
.346	143	1283	.377	180.9	1.24
.346	160	3445	.402	180.8	.99
.346	154	3456	.396	181.2	1.05
.346	163	3209	.402	181.1	1.05
.346	158	5591	.390	182.2	1.04

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.346	155	5820	.391	182.4	1.01
.346	162	5455	.393	182.4	.96
.346	161	3326	.408	181.5	.97
.346	163	2730	.404	180.9	1.02
.346	164	3085	.394	181.2	.94
.347	154	3275	.399	180.6	1.13
.347	166	3158	.404	180.4	1.04
.347	156	3504	.402	181.9	1.06
.347	159	2108	.397	182.4	1.00
.347	144	1271	.405	185.4	1.27
.347	164	4104	.401	182.5	1.01
.347	158	3360	.404	180.8	1.02
.347	161	3253	.401	180.8	.98
.347	165	4754	.401	182.1	.98
.348	161	4021	.391	181.7	.97
.348	163	3259	.403	180.6	.98
.348	159	3462	.402	180.7	1.06
.348	162	3035	.403	181.2	1.03
.348	147	1855	.398	189.6	1.31
.349	161	3445	.405	182.2	1.04
.349	161	3263	.406	181.1	1.03
.349	162	3111	.399	181.3	.94
.349	158	3354	.406	180.9	1.02
.350	164	4927	.395	182.2	1.02
.350	163	4442	.405	183.1	1.05
.350	132	927	.496	198.7	1.27
.350	153	5319	.396	182.0	1.08
.350	165	3741	.402	181.9	.94
.350	163	3068	.397	180.7	.99
.350	154	1373	.380	180.7	.87
.350	156	3247	.404	180.9	.98
.350	156	3489	.401	180.9	.98
.351	163	5497	.395	182.8	.93
.351	158	3168	.401	180.6	.97
.351	161	3316	.408	181.1	.93
.351	164	4803	.400	182.0	.94
.351	161	3371	.398	181.4	.95
.351	134	996	.497	199.0	1.43
.352	154	3402	.400	180.7	.98
.352	163	3482	.401	181.1	1.04
.352	159	5515	.389	182.0	1.00
.352	164	4762	.394	182.0	.96
.352	161	4807	.398	181.8	1.04
.352	153	5350	.396	182.1	1.22
.352	165	2767	.404	180.4	1.05
.352	159	3295	.397	181.3	1.07
.352	163	3730	.402	181.9	.98
.352	163	5262	.396	182.4	.97
.353	158	3269	.403	180.9	1.09
.353	164	2791	.395	180.7	.94

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.353	153	334	.373	182.7	1.12
.353	153	5384	.398	181.9	1.12
.353	154	3413	.404	181.2	1.02
.353	132	906	.497	199.0	1.25
.353	164	2751	.398	181.2	.98
.353	159	3446	.398	180.3	.97
.354	159	5794	.390	182.5	.99
.354	161	3243	.401	180.6	1.03
.354	160	3430	.401	181.7	1.00
.354	160	3477	.405	181.1	1.03
.354	160	3165	.399	180.7	1.06
.354	163	5244	.403	182.0	.99
.354	144	1034	.487	199.5	1.27
.354	134	803	.468	198.0	1.36
.354	159	3509	.402	181.7	.98
.355	160	3227	.406	180.9	1.01
.355	160	3316	.399	181.3	1.08
.355	160	3343	.401	181.2	1.05
.355	157	3253	.408	180.1	.91
.355	152	2660	.425	180.4	1.07
.355	158	3355	.400	180.7	1.07
.355	161	3472	.402	181.9	.91
.356	157	17	.386	189.6	1.11
.356	164	4774	.400	182.0	.93
.356	161	5534	.401	182.5	1.03
.356	160	4636	.397	182.0	1.02
.356	159	5792	.394	182.5	.98
.356	159	3269	.404	180.9	1.02
.356	165	3365	.404	182.0	.95
.357	160	3897	.401	181.8	.99
.357	151	373	.380	182.1	1.13
.357	157	3370	.402	181.8	1.11
.357	160	4496	.404	184.9	1.29
.357	159	3692	.396	182.0	.94
.357	161	3185	.400	180.6	.98
.357	162	3290	.406	180.9	.93
.357	163	3462	.395	181.7	.92
.357	161	3228	.398	180.2	.98
.357	161	3237	.401	180.9	1.02
.358	160	4603	.398	182.0	1.06
.358	161	4455	.401	181.7	1.00
.358	159	4766	.399	182.3	.94
.358	159	3338	.404	180.8	.97
.358	152	5330	.393	182.2	1.08
.359	156	2100	.383	182.4	1.25
.359	152	7445	.326	191.1	1.19
.359	161	3553	.401	181.8	1.05
.359	166	2790	.405	181.4	1.02
.359	156	3147	.402	180.6	1.12
.359	158	3509	.401	182.1	1.00

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.359	159	3243	.405	180.6	1.06
.359	158	3189	.401	180.4	.95
.359	159	5364	.396	181.9	1.01
.360	154	3338	.405	180.6	1.06
.360	161	3494	.406	181.5	.96
.360	156	3185	.402	180.6	.97
.361	160	3898	.404	182.1	.98
.361	162	3552	.401	180.6	1.25
.361	156	3499	.402	180.6	1.04
.361	164	3333	.403	182.0	1.05
.361	147	934	.432	201.6	1.27
.362	161	5974	.396	182.6	.97
.362	166	3412	.403	181.3	.97
.362	162	3924	.396	182.4	1.02
.362	161	3340	.399	180.0	1.09
.362	161	6035	.385	168.3	1.27
.363	161	3962	.394	182.5	.94
.363	163	5270	.401	182.3	.93
.363	160	3563	.401	180.8	1.01
.363	159	3383	.399	180.9	1.06
.363	164	3277	.399	179.8	1.09
.363	161	5517	.398	182.4	1.02
.364	163	3994	.394	182.3	.95
.364	160	5367	.394	182.0	1.03
.364	160	3254	.403	180.3	1.03
.364	157	3462	.403	180.6	1.00
.364	163	4539	.392	181.8	.97
.364	159	3343	.403	180.7	1.14
.365	161	5520	.395	182.5	.91
.365	143	1208	.479	200.4	1.32
.365	160	3563	.405	181.3	1.10
.365	160	5262	.396	182.2	1.00
.365	162	5449	.395	182.4	.99
.365	157	3310	.404	181.2	1.14
.365	160	4203	.404	182.3	1.02
.365	159	3462	.399	180.4	1.10
.366	159	3248	.403	180.4	1.09
.366	166	4028	.402	182.3	.91
.366	153	1116	.414	183.9	1.44
.367	156	5426	.398	182.2	1.04
.367	160	3414	.404	181.4	1.03
.367	163	3211	.401	181.0	.94
.367	161	3822	.401	182.3	.91
.367	160	3273	.403	181.1	1.07
.368	162	2694	.404	180.4	1.02
.368	161	5309	.405	182.4	1.00
.368	160	5523	.390	182.4	.93
.368	159	3387	.400	181.1	.97
.368	162	4647	.396	182.2	1.03
.368	160	5387	.393	182.2	1.25

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.368	161	5213	.395	181.7	.94
.369	162	3488	.408	182.4	1.02
.369	161	5500	.393	182.4	.98
.370	162	3354	.403	181.8	.98
.370	165	2944	.400	181.5	1.00
.370	163	5274	.394	182.4	.97
.371	163	3412	.405	181.9	1.02
.371	163	3698	.402	181.9	.84
.371	162	3569	.402	182.0	1.07
.371	160	5478	.393	182.0	.97
.371	159	5367	.395	182.0	1.00
.372	160	5455	.396	181.7	1.02
.372	163	3462	.403	182.0	1.01
.372	145	1116	.397	184.4	1.25
.372	160	5440	.398	182.1	1.03
.373	161	3440	.400	182.2	.93
.373	153	3306	.404	180.6	1.16
.373	162	3462	.393	181.7	1.01
.373	159	3338	.400	181.1	1.14
.373	161	5491	.400	182.4	1.01
.374	165	4069	.403	182.5	1.03
.374	157	3398	.395	181.5	1.08
.374	162	4312	.396	182.5	1.02
.374	151	5308	.396	181.7	1.12
.374	156	3329	.400	181.4	1.09
.374	159	5403	.400	182.4	1.04
.375	151	5383	.393	181.2	1.13
.375	162	3203	.404	181.4	.91
.375	151	3387	.402	181.7	.93
.375	159	3359	.406	180.8	.93
.375	156	3397	.395	181.4	1.01
.375	159	3333	.403	181.8	1.08
.376	160	3351	.397	180.0	1.05
.376	165	3472	.398	182.2	1.05
.376	165	3714	.404	181.9	1.07
.376	162	3800	.396	182.3	1.04
.376	158	3428	.405	181.9	1.06
.376	157	3300	.402	180.9	1.09
.376	163	3270	.407	180.4	1.02
.376	160	3434	.406	181.3	1.02
.376	159	4469	.400	183.0	.89
.377	161	3866	.398	181.8	1.02
.377	163	3296	.405	181.9	1.09
.377	151	5680	.388	181.5	1.06
.378	158	5409	.395	181.6	1.01
.378	153	3248	.402	180.4	1.17
.378	135	1116	.414	183.9	1.38
.378	161	3681	.400	182.0	.98
.379	162	3531	.402	181.0	.93
.379	164	3344	.400	181.1	1.02

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.379	153	5364	.396	182.0	1.03
.379	163	3472	.404	181.1	1.05
.380	162	3355	.400	181.1	.89
.380	161	5275	.397	182.0	1.05
.380	146	1044	.490	179.8	1.26
.380	141	1010	.457	199.5	1.29
.380	160	3870	.397	182.0	1.03
.380	161	5443	.394	182.2	.98
.380	162	3359	.403	181.1	1.02
.381	160	3671	.397	182.0	1.03
.381	160	3365	.406	180.7	.89
.381	162	4284	.397	182.4	1.04
.381	159	5353	.394	182.0	1.01
.381	144	1314	.393	184.6	1.25
.381	148	915	.430	201.8	1.23
.381	144	1043	.488	199.8	1.28
.381	162	3339	.401	181.4	1.03
.381	166	3386	.403	181.1	.93
.382	161	5395	.396	182.3	.95
.382	160	5332	.402	182.2	1.01
.382	145	1046	.489	200.4	1.28
.382	165	4072	.402	18. 7	.96
.382	168	2299	.396	181.7	.87
.382	163	5272	.404	182.5	1.00
.383	160	3504	.410	182.4	1.00
.383	158	4041	.411	182.8	1.00
.383	162	3504	.405	181.9	.99
.384	161	3305	.405	181.1	1.05
.384	160	5403	.403	182.-	1.05
.385	158	6171	.394	182.8	.97
.385	165	4190	.397	182.2	1.00
.386	163	3779	.402	182.1	1.06
.387	161	5387	.397	181.9	1.01
.387	165	4137	.398	182.1	1.00
.387	144	1049	.487	199.7	1.30
.388	163	3671	.400	181.6	.96
.388	160	3266	.405	180.0	1.09
.388	159	1234	.391	183.9	1.25
.389	162	3350	.400	182.0	.97
.389	160	5771	.392	182.3	1.04
.390	161	5531	.401	182.9	1.03
.391	159	3301	.404	181.1	1.26
.392	146	1094	.489	199.8	1.24
.392	150	928	.434	201.9	1.25
.392	156	3178	.403	181.3	.87
.394	164	3375	.400	180.7	1.00
.394	166	4198	.398	182.5	1.00
.394	156	3456	.404	181.9	1.04
.394	163	3494	.394	181.3	.94
.395	165	4695	.400	182.7	1.00

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.395	162	4177	.405	182.7	.97
.395	162	5426	.401	182.4	1.02
.396	161	4214	.402	182.3	.89
.396	164	5259	.395	182.1	.98
.396	166	3466	.402	182.1	1.02
.396	164	5506	.388	181.9	.95
.396	162	3306	.402	181.0	.86
.397	162	3541	.408	180.6	1.05
.397	165	3375	.404	181.4	.98
.397	160	3462	.394	181.5	1.00
.398	157	3380	.405	180.9	.92
.398	145	1034	.477	200.3	1.24
.398	159	5449	.397	182.5	.96
.398	165	5403	.398	182.0	.94
.398	161	34 9	.404	182.1	1.05
.398	160	3387	.400	180.9	1.09
.398	132	764	.463	198.0	1.44
.399	158	3149	.405	181.9	1.13
.399	149	1066	.490	200.1	1.24
.399	165	3418	.401	181.1	1.05
.400	161	3382	.397	181.4	1.00
.400	161	3338	.401	181.9	1.04
.401	158	3515	.402	181.7	1.01
.401	159	5435	.395	181.6	1.01
.401	164	3354	.401	181.4	1.04
.401	150	1020	.488	199.5	1.23
.403	156	3349	.399	180.8	1.10
.405	143	1304	.390	185.0	1.15
.405	145	1028	.476	199.4	1.29
.405	160	3326	.408	181.6	1.01
.406	0	2089	.357	191.4	1.47
.406	160	3263	.403	180.9	1.06
.406	161	3445	.406	180.8	.94
.407	140	943	.457	198.9	1.24
.409	133	1115	.414	183.9	1.44
.410	163	3703	.398	182.5	.95
.412	163	5252	.399	182.4	1.01
.412	152	5302	.395	181.8	1.07
.412	161	3367	.400	180.7	1.04
.413	152	5270	.396	182.1	1.03
.413	158	4970	.394	182.2	1.11
.413	163	3762	.400	181.9	1.08
.414	161	3456	.399	181.7	1.02
.414	163	3957	.400	182.2	.94
.414	158	5447	.392	181.8	1.05
.414	161	5304	.395	182.1	1.02
.415	144	1028	.488	200.1	1.35
.415	165	5283	.404	182.5	1.00
.416	159	5421	.393	182.2	1.00
.416	161	5537	.402	182.6	1.07

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.418	159	3875	.395	181.5	.95
.418	164	3355	.400	181.7	.93
.419	160	3263	.403	181.1	1.09
.420	164	4028	.402	182.3	1.02
.420	160	5440	.393	182.5	1.04
.421	166	4699	.398	182.1	.97
.421	157	5022	.391	181.5	1.01
.421	156	6106	.393	182.3	1.00
.422	164	3344	.399	181.5	1.05
.422	155	3360	.404	180.4	1.05
.422	161	3355	.400	181.9	1.10
.425	161	5262	.396	182.0	.96
.426	165	3301	.398	180.5	.97
.426	162	2220	.400	181.6	1.00
.426	154	6234	.390	182.3	.93
.426	159	4751	.401	181.8	1.06
.427	162	3552	.404	182.1	1.03
.428	133	1116	.414	183.9	1.45
.429	149	1043	.489	200.1	1.22
.429	159	5870	.397	182.6	.98
.430	144	870	.467	198.7	1.24
.430	162	3461	.404	180.9	.98
.430	165	4526	.405	182.0	1.12
.432	149	861	.471	198.4	1.32
.432	151	5172	.400	182.0	1.00
.432	160	5489	.396	181.9	.94
.433	165	2901	.397	181.2	.97
.434	160	3430	.396	180.7	1.08
.435	159	3521	.404	181.6	1.08
.435	162	3681	.392	181.6	1.07
.439	158	5421	.396	181.9	1.02
.444	160	3340	.402	179.6	.97
.444	160	4256	.397	181.6	.97
.444	149	972	.480	200.1	1.29
.446	158	3440	.402	180.4	1.12
.448	167	3370	.399	180.8	1.06
.453	155	3253	.402	180.6	1.10
.455	159	5356	.402	182.4	1.02
.456	150	951	.477	200.6	1.24
.457	160	3698	.404	182.2	1.00
.457	56	1831	.282	191.3	1.31
.460	159	5811	.389	182.0	1.00
.461	166	4717	.401	182.5	.99
.461	161	3542	.402	180.8	1.09
.461	153	3300	.404	181.2	1.10
.462	154	5149	.394	181.3	.91
.467	160	3413	.402	181.4	1.09
.467	158	3180	.401	180.3	1.00
.468	160	3283	.408	182.0	1.14
.469	149	868	.471	196.4	1.28

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.471	149	5356	.395	182.2	1.16
.478	144	0	.394	190.1	1.51
.486	161	3441	.399	181.3	.95
.499	160	3467	.401	181.2	1.05
.499	158	5432	.394	182.2	1.09
.501	144	0	.391	190.4	1.40
.512	63	310	.410	194.2	1.29
.513	153	6094	.390	182.3	1.25
.514	153	6092	.392	182.4	1.27
.515	162	3493	.404	181.6	1.12
.535	160	3206	.403	180.7	1.24
.537	63	331	.377	195.2	1.42
.541	150	6213	.390	182.0	1.09
.552	160	3360	.396	181.0	1.04
.554	162	4532	.407	185.6	1.15
.577	156	3392	.399	180.2	1.16
.637	91	250	.480	191.4	1.24
.673	90	239	.465	192.1	1.06
.674	160	5372	.396	181.9	1.06
.745	65	207	.461	190.2	1.14
.765	162	3195	.403	180.7	1.30
.803	159	3392	.404	180.3	1.10
.852	91	258	.476	190.7	1.23
.932	153	5512	.393	181.5	1.05
.996	134	1116	.414	187.9	1.60

CRUISE GUIDE	AIRSPEED	PRESSURE ALTITUDE	TORQUE	ROTOR RPM	NZ
.471	149	5356	.395	182.2	1.16
.478	144	0	.394	190.1	1.51
.486	161	3441	.399	181.3	.95
.499	160	3467	.401	181.2	1.05
.499	158	5432	.394	182.2	1.09
.501	144	0	.391	190.4	1.40
.512	63	310	.410	194.2	1.29
.513	153	6094	.390	182.3	1.25
.514	153	6092	.392	182.4	1.27
.514	162	3493	.404	181.6	1.12
.535	160	3206	.403	180.7	1.24
.537	63	331	.377	195.2	1.42
.541	150	6213	.390	182.0	1.09
.552	160	3360	.396	181.0	1.04
.554	162	4532	.407	185.6	1.15
.577	156	3392	.399	180.2	1.16
.637	91	250	.480	191.4	1.24
.673	90	239	.465	192.1	1.06
.674	160	5372	.396	181.9	1.06
.745	85	207	.461	190.2	1.14
.755	162	3195	.403	180.7	1.36
.833	150	3392	.404	180.3	1.10
.852	91	258	.476	190.7	1.23
.932	153	5512	.393	181.5	1.05
.996	134	1116	.414	183.9	1.60